A POPULAR DISPLAY OF THE WONDERS OF NATURE

EXCLUSIVELY SELECTED FROM

THE TRANSACTIONS OF THE ROYAL SOCIETY OF LONDON.

BY THE REV. C. C. CLARKE,

Author of

"The Wonders of the World and of the Heavens."

THE BEAVERS

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NATURE

AND

NATURAL PHILOSOPHY.

Account of the Burning Concave Glass, made at Lyons, by M. Villett

Its figure is round; being rather above thirty inches in diameter. On one side it has a circular frame of steel, that it may keep its just size. It is easy to remove it from place to place, though it weigh above a hundred weight, and is easily put in all sorts of positions. The focus is distant from the centre of the glass about three feet, and is about half an inch in diameter. One may pass one's hand through it, if it be done nimbly; but if it remain there for one second only, there is danger of receiving much hurt.

Green wood takes fire in it in an instant, as do also many other bodies.

A small piece of pot-iron was melted, and ready to drop down, in - - - - -	40 *Sec.*
A piece of silver was pierced in - - - -	24
A thick nail was melted in - - - -	30
The end of a sword-blade was burnt in - -	43
A brass counter was pierced in - - -	6
A piece of red copper was melted, ready to drop down, in - - - - -	42
A piece of quarry-stone was vitrified in - -	45
Watch spring steel melted in - - -	9
A mineral stone was calcined and vitrified in -	1
A piece of mortar was vitrified in - -	52

In short, there is hardly any body which is not destroyed by this heat. To melt by it any great quantity of metal much time would be required, the action of burning not being performed but within the size of the focus; so that usually only small pieces are exposed to it.

M. de Villette afterwards made another of 34 inches diameter, which melted all sorts of metals, even iron itself, of

the thickness of a silver crown, in less than a minute of time, and vitrified brick in the same time; and as for wood, whether green or dry, it set it on fire in a moment.

M. Auzout's Speculations on the Changes likely to be discovered in the Earth and Moon, by their Inhabitants

I have sometimes thought on the changes which it is likely the supposed inhabitants of the moon might discover in our earth, to see whether reciprocally I could observe any such in the moon. For example, that the earth would appear to the people of the moon to have a different face in the several seasons of the year; and to have another appearance in winter, when there is scarcely any thing green on a very great part of the earth; when there are countries all covered with snow, others all covered with water, others all obscured with clouds, and that for many weeks together Another face in spring, when the forests and fields are green. Another in summer, when all are yellow, &c. Methinks such changes are considerable enough, by the force of the reflections of light, to be observed, since so many differences of lights are seen in the moon.

We have rivers considerable enough to be seen, and they enter far enough into the land, and have a breadth sufficient to be observed. There are fluxes in certain places, that reach into large countries, capable of making there some apparent change; and in some of our seas there float sometimes such bulky masses of ice, that are far larger than the objects which we are assured we can see in the moon. Again, we cut down whole forests, and drain marshes, of an extent large enough to cause a considerable alteration: and men have made such work, as have produced changes large enough to be perceived. In many places also are volcanoes sufficiently large to be distinguished, especially in the shadow: and when forests or great towns are on fire, it can hardly be doubted, but these luminous objects would appear, either in an eclipse of the earth, or when such parts of the earth are not illuminated by the sun. I have sometimes thought whether it might not be, that all the seas of the moon, if there must be seas, were not on the side of the other hemisphere, and that for this cause it might be that the moon turns not her axis, as our earth, in which the lands and seas are, as it were, balanced. This also may be the cause why there appear not any clouds there, nor any vapours considerable enough to be seen, that are raised from

the earth; and that this absence of vapours may also be the reason that there is no twilight there, as it seems there is none, I myself at least not being able to discern any: for I think the reputed inhabitants of the moon might see our twilight, since it is much stronger than the light afforded us by the moon, even when full; for a little after sun-set, when we receive no more the first light of the sun, the sky is far clearer than it is in the fairest night of the full moon. And since we observe in the moon, when she is increasing or decreasing, the light she receives from the earth, we cannot doubt but that the people of the moon should likewise see in the earth the light with which the moon illuminates it, with perhaps the difference there is between their magnitude. Much more then should they see the crepuscular light, being, as was said, incomparably greater. But yet we see not any faint light beyond the section of the light, which is almost every where equally strong, and we there distinguish nothing at all, not so much as that clearest part called aristarchus, or porphyrites, as I have often tried; although one may there see the light which the earth sends thither, which is sometimes so strong, that in the moon's decrease I have often distinctly seen all the parts of the moon that were not enlightened by the sun, together with the difference of the clear parts and the spots, so far as to be able to discern them all. The shadows also of all the cavities of the moon seem to be stronger than they would be if there were a second light. For although afar off the shadows of our bodies, environed with light, seem to us almost dark; yet they do not appear so in the same degree as the shadows of the moon; and those on the edge of the section should not appear in the like manner.

Swarms of mischievous Insects, in New England.

Some few years since in New England, there was such a swarm of a certain kind of insects, that for the space of 200 miles they destroyed all the trees of the country. There appeared innumerable little holes in the ground, out of which they broke forth in the form of maggots, which turned into flies, with a kind of tail or sting, which they struck into the tree, and thereby envenomed and killed it.

The like plague is said to happen frequently in the country of the Cossaks or the Ukraine, where in dry summers they are infested with such swarms of locusts, driven thither by an east or south-east wind, that they darken the air in the

fairest weather, and devour all the corn of that country; laying their eggs in autumn, and then dying; but the eggs, of which every one lays two or three hundred, hatching the next spring, produce again such a number of locusts, as to be far more destructive than before, unless rains fall, which kill both eggs and the insects themselves, or unless a strong north or north-west wind arise, which drives them into the Euxine sea.

Observations on the Barometer. By Dr. Wallis.

The Doctor never observed the quicksilver higher than 30 inches, nor lower than 28, at least within $\frac{1}{16}$ of an inch of these numbers, either over or under.

In thick foggy weather, he found the quicksilver rise; which he ascribes to the heaviness of the vapours in the air.

In sun-shiny weather it rises also, and commonly the clearer the weather the higher it is; which may be owing partly to the vapours raised by the sun and increasing the weight of the air; partly to the heat which adds to the elasticity of the air; which latter he mentions, because in sun-shiny weather, which became afterwards cloudy for an hour or two, the quicksilver has fallen; and then on the sun's breaking out again, it has risen as before.

In rainy weather it falls, because the air is light in proportion to the quantity of vapours that falls; and also in snowy weather, but not so much as in rain; and sometimes it has fallen upon a hoar-frost in the night.

In windy weather it generally falls, and more discernibly than in rainy, owing possibly to the wind's moving the air laterally; and thereby preventing its pressure downwards; and he never found it lower than in high winds.

He observed the quicksilver fall without any visible cause, but upon looking abroad, he found it had rained at some distance; whereby the heavier air might have in part discharged itself on the lighter.

The Rotation of Jupiter on his Axis. By Mr. Hook and M. Cassi.

About nine o'clock at night, May 9th, 1664, Mr. Hook observed, with a good 12-foot telescope, a small spot in the largest of the three obscurer belts of Jupiter; and, observing it from time to time, he found that within two hours after,

the said spot had moved from east to west, about half the length of the diameter of Jupiter.

According to M. Cassini there are two sorts of spots to be seen in the disk of Jupiter; the one being only the shadows of his satellites, the other sort resembling those that are seen in the moon; and they are perhaps of the same nature with those called belts. They move from the eastern to the western limb; their apparent motion is unequal, and swifter near the centre than the circumference; and they are never seen so well as when they approach the centre; for in approaching the circumference they become very narrow, and almost imperceptible; which seems to argue that they are flat and superficial.

Among these spots, there is none so observable as that situated in the northern part of the southern belt. Its diameter is $\frac{1}{10}$ of Jupiter's; its centre when nearest is distant from that of Jupiter about $\frac{1}{3}$ of the semidiameter of that planet.

M. Cassini, after many observations during the summer of 1665, found that the period of its apparent revolution is 9 hours 56 minutes. He continued to observe this spot till the beginning of 1666, when Jupiter approached to the beams of the sun; but after he got out of them it was difficult to be discerned.

General Heads for a Natural History of a Country. By Mr. Boyle.

The things to be observed in such a History may be variously divided: as into supraterraneous, terrestrial, and subterraneous.

1. To the first sort of particulars belong the longitude and latitude of the place, and, consequently, the length of the longest and shortest days and nights, the climate, the parallels, &c.; what fixed stars are, and what are not seen there.

2. Concerning the air, may be observed its temperature, as to the first four qualities and the measures of them: its weight, clearness, refractive power; its subtilty or grossness; its abounding with or wanting salts, its variations according to the seasons of the year, and the times of the day; what duration the several kinds of weather usually have; what meteors it mostly produces, and in what order they are generated; and how long they usually last; especially, what winds it is subject to; whether any of them be stated and

ordinary, &c. What diseases are epidemical; what is the usual salubrity or insalubrity of the air; with what constitutions it agrees better or worse than others.

3. Concerning the water, may be observed the sea, its depth, degree of saltness, tides, currents, &c. Next rivers, their width, length, course, inundations, goodness, lightness of waters, &c. Then lakes, ponds, springs, and especially mineral waters, their kinds, qualities, virtues, and how examined. To the waters belong also fishes, their kinds, whether salt or fresh water fish; their quantity, size, goodness, seasons, haunts, peculiarities of any kind, and the ways of taking them, especially those that are not purely mechanical,

4. In the earth may be observed,

1. Itself. 2. Its inhabitants and its productions, both external and internal.

First, In the earth itself may be observed, its dimensions, situation, east, west, north, and south: its figure, its plains and valleys, and their extent; its hills and mountains, and their height; and whether they lie scattered or in ridges, and in what directions they run, &c. What promontories, fiery or smoking hills, &c. What the magnetical declination is in several places, and the variations of that declination in the same place: what the nature of the soil is, whether clay, sandy, &c. or good mould; and what grains, fruits, and other vegetables, do the most naturally agree with it: also, by what particular arts the inhabitants improve the advantages and remedy the inconveniences of their soil?

Secondly, There must be given a careful account of the inhabitants themselves, particularly their stature, shape, colour, features, strength, agility, beauty, complexions, hair, diet, inclinations, and customs. Of the women, there may be observed their fruitfulness or barrenness, their hard or easy labour, &c. What diseases both women and men are subject to, and unusual symptoms attending them.

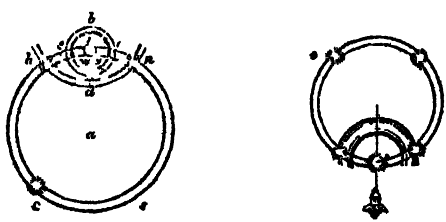
As to the external productions of the earth, the inquiries may be such as these: What grasses, grains, herbs, flowers, fruit-trees, timber-trees, coppices, groves, woods, forests, &c. What peculiarities are observable in any of them: what soils they best thrive in. What animals the country has, either wild or tame

The internal productions or concealments of the earth, are here understood to be the riches that lie hid under the ground, and are not already referred to other enquiries: what sorts of minerals and quarries the country affords, and

the particular conditions both of the quarries and the stones: also, how the beds of stone lie, in reference to north and south, &c. What clays and earths it affords, as tobacco pipe-clay, marls, fullers' earths, earths for potters' wares, boluses, and other medicated earths: what other minerals it yields, as coals, salt-mines, or salt-springs, alum, vitriol, sulphur, &c. What metals the country yields, and a description of the mines, their number, situation, depth, signs, waters, damps, quantities of ore, goodness of ore, extraneous things, and ways of reducing their ores into metals, &c.

Of four Suns observed in France.

On the 9th of April, 1666, about half an hour past nine, there appeared three circles in the sky. One of them, *s c h n* (see engraving), was very large, a little interrupted, and white every where, without the mixture of any other colour. It passed through the middle of the sun's disk, and was parallel to the horizon. Its diameter was above 100 degrees, and its centre not far from the zenith *a*.



The second, *d e b o*, was much less, and deficient in some places, having the colours of a rainbow, especially in that part which was within the great circle. It had the true sun for its centre.

The third, *h d n*, was less than the first, but greater than the second: it was not entire, but only an arch or portion of a circle, whose centre was far distant from that of the sun, and whose circumference about its middle *d* was joined to that of the least circle, intersecting the greatest circle at its two extremities *h n*. In this circle were discerned also the colours of a rainbow, but they were not so strong as those of the second.

At the part where the circumference of this third circle closed with that of the second, there was a great brightness of rainbow-colours mixed together: and at the two extremities, where this second circle intersected the first, appeared two parhelias or mock suns *h n*; which shone very bright, but not so bright or so well defined as the true sun. The false sun *h*, towards the south, was larger, and far more luminous than that towards the east.

Besides those two parhelias which were on the two sides of the true sun, in the intersection of the first and third circle, there was also upon the first great circle a third mock sun *c*, situated to the north, which was less and less bright than the two others. So that at the same time there were seen four suns in the heavens. There was also a very dark space between *d* and *r*.

This appearance is considered as one of the most remarkable that can be seen, by reason of the excentricity of the circle *h d n*, and because the parhelia were not in the intersection of the circle *d e b o* with the great circle *s c h n*, but in that of the semicircle *h d n*. Which are different from the position of those five suns seen at Rome on March 29. 1629, between two and three o'clock A. M., two of them appearing in the intersection of a circle passing through the sun's disk, with another that was concentric with the sun, as in the engraving.

Hypothesis on the Flux and Reflux of the Sea. By Dr. JOHN WALLIS.

THE sea's ebbing and flowing has so great a connexion with the moon's motion, that all philosophers have attributed much of its cause to the moon, which either by some occult quality, or particular influence which it has on moist bodies, or by some magnetic virtue, drawing the water towards it, which should therefore make the water highest where the moon is vertical, or by its gravity and pressure downwards upon the terraqueous globe, which should make it lowest, where the moon is vertical, or by whatever other means, has so great an influence on, or at least connexion with, the sea's flux and reflux, that it would seem very unreasonable to separate the consideration of the moon's motion from that of the sea: the periods of tides, to say nothing of the greatness of them near the new and full moon,

so constantly waiting on the moon's motion, that it may be well presumed, that either the one is governed by the other, or at least both by some common cause:

But the first that I know who took in the consideration of the earth's motion, diurnal and annual, was Galilæo, who, in his System of the World, has a particular discourse on this subject; which, from the first time I read it, seemed to me so very rational, that I could never be of another opinion, than that the true account of this great phenomenon was to be referred to the earth's motion as the principal cause of it; yet that of the moon not to be excluded as to the determining the periods of tides, and other circumstances concerning them. And though it be manifest enough, that Galilæo, as to some particulars, was mistaken in the account which he there gives of it; yet that may be very well allowed, without any blemish to so deserving a person, or prejudice to the main hypothesis: for that discourse is to be looked upon only as an essay of the general hypothesis; which as to particulars was to be afterwards adjusted, from a good General History of Tides, which it is manifest enough that he had not.

1. The diurnal reciprocation; whereby twice in somewhat more than 24 hours we have a flood and an ebb, or a high-water and low-water.

2. The menstrual; whereby in one synodical period of the moon, suppose from full moon to full moon, the time of those diurnal vicissitudes moves round through the whole compass of the natural day of 24 hours; as for instance, if at the full moon the full sea be at such or such a place just at noon, it shall be the next day at the same place somewhat before one of the clock; the day following, between one and two; and so onward, till at the new moon it shall be at midnight; the other tide, which in the full moon was at midnight, now at the new moon coming to be at noon; and so forward, till at the next full moon the full sea shall at the same place come to be at noon again: again, that of the spring-tides and neap-tides; about the full moon and new moon the tides are at the highest, at the quadratures the tides are at the lowest; and at the times intermediate, proportionably.

3. The annual; whereby it is observed, that at some part of the year, the spring-tides are yet much higher than the spring-tides at others, which times are usually taken to be at the spring and autumn, or the two equinoxes.

Now in order to give account of these three periods, according to the laws of motion and mechanic principles, we

shall first take for granted, what is now pretty commonly entertained by those who treat of such matters, that a body in motion is apt to continue its motion, and in the same degree of celerity, unless hindered by some contrary impediment, like as a body at rest is apt to continue so, unless by something acting on it put into motion; and accordingly, if on a board or table some loose incumbent weight be for some time moved, and have thereby contracted an impetus to motion at such a rate; if that board or table chance by some external obstacle or otherwise to be stopped or considerably retarded in its motion, the incumbent loose body will shoot forward upon it; and contrariwise, in case that board or table chance to be accelerated or put forward with a considerably greater speed than before, the loose incumbent body, not having yet obtained an equal impetus with it, will be left behind, or seem to fly backward upon it.

Or, if a broad vessel of water, for some time evenly carried forward with the water in it, chance to meet with a stop, or to slack its motion, the water will dash forward and rise higher at the fore part of the vessel; and contrariwise, if the vessel be suddenly put forward faster than before, the water will dash backwards, and rise at the hinder part of the vessel. So that an acceleration or retardation of the vessel which carries it will cause a rising of the water in one part, and a falling in another; although, by its own weight, it will again be reduced to a level as it was before. And, consequently, supposing the sea to be but as a loose body, carried about with the earth, but not so united to it, as necessarily to receive the same degree of impetus with it as its fixed parts do, the acceleration or retardation in the motion of this or that part of the earth will cause such a dashing of the water, or rising at one part with a falling at another, as what we call the flux and reflux of the sea.

Now, this premised, we are next to suppose the earth carried about with a double motion; the one annual, the other diurnal, whereby the whole moves upon its own axis, and each point in its surface describes a circle. It is then manifest, that if we suppose that the earth moved but by any one of these motions, and that regularly, the water having once attained an equal impetus thereunto, would still hold equal pace with it; but the true motion of each part of the earth's surface being compounded of those two motions, the annual and diurnal; while a point in the earth's surface moves about its centre, and at the same time its centre be carried forwards, the true motion of that point

forwards is made up of both those motions; but while the point on one side moves backward contrary to the annual motion, so the true motion is but the difference of it; so that the diurnal motion in that part of the earth which is next the sun abates the progress of the annual, and in the other part, which is from the sun, it increases it, that is, in the day-time there is an abatement, and in the night-time an addition to the annual motion, about as much as the earth's diameter: which would afford us a cause of two tides in twenty-four hours; the one upon the greatest acceleration of motion, the other upon its greatest retardation.

And thus far Galilæo's discourse holds well enough as to principle; but then in this it comes short, that as it gives an account of two tides, so those two tides are always at noon and midnight; whereas experience tells us that the time of tides moves in a month's space through all the 24 hours. Of this he gives us no account. For though he takes notice of a menstrual period, yet he does it only as to the *quantity* of the tides, greater or less; not as to the *time* of the tides, sooner or later.

The earth and moon being known to be bodies of so great connexion (whether by any magnetic, or what other tie I will not determine) as that the motion of the one follows that of the other, may well enough be looked upon as one body, or rather one aggregate of bodies which have one common centre of gravity; which centre, according to the known laws of statics, is in a straight line connecting their respective centres, so divided as that its parts be in reciprocal proportion to the gravities of the two bodies.

Now supposing the earth and moon jointly as one body, carried about by the sun in the great orb of the annual motion; this motion is to be estimated according to the laws of statics, as in other cases, by the motion of the common centre of gravity of both bodies. For we are accustomed in statics to estimate a body or aggregate of bodies to be moved upwards, downwards, or otherwise, so much as its common centre of gravity is so moved, howsoever the parts may change places amongst themselves. And accordingly the line of the annual motion will be described, not by the centre of the earth, nor by the centre of the moon, but by the common centre of gravity of the bodies, the earth and moon, as one aggregate.

So that in pursuance of Galilæo's notion, the menstrual adding to or detracting from the annual motion should either leave behind or cast forward the loose waters in-

cumbent on the earth, and thereby cause a tide or accumulation of waters; and most of all at the full moon and new moon, where those accelerations or retardations are greatest. Now this menstrual motion, if nothing else were superadded to the annual, would give us two tides in a month, and no more; the one upon the acceleration, the other on the retardation, at new moon and full moon; and two ebbs at the two quarters; and in the intervals rising and falling water. But the diurnal motion superadded, doth the same to this menstrual, as Galilæo supposes it to do to that annual; that is, adds to, or subtracts from, the menstrual acceleration or retardation; and so gives us tide upon tide.

But here also we are to take notice, that though all parts of the earth by its diurnal motion do turn about its axis, and describe parallel, yet not equal circles, but greater near the equinoctial, and less near the poles; which may be a cause why the tides in some parts may be much greater than in others. But this belongs to the particular considerations, not to the general hypothesis.

Of Worms that eat Stones and Mortar. By M. de la Voye.—

In a large and very ancient wall of free-stone in the Benedictines' Abbey at Caen in Normandy, facing southward, are found many stones so eaten by worms, that one may run one's hand into most of the cavities. In these cavities there is abundance of live worms with their excrement, and of the stone dust which they eat. Between many of the cavities there remain but leaves as it were of stone, very thin, which part them. I have taken some of these living worms, which I found in the eaten stone, and put them into a box with several bits of the stone, leaving them there together for the space of eight days; and then opening the box, the stone seemed to me so sensibly eaten, that I could no longer doubt of it.

These worms are inclosed in a shell which is greyish, and of the size of a barley-corn, sharper at one end than the other. By means of an excellent microscope I have observed, that the shell is all overspread with little stones and small greenish eggs; and that there is at the sharpest end a little hole, by which these creatures discharge their excrement; and at the other end a somewhat larger hole, through which they put out their heads and fasten themselves to the stones they gnaw. They are not so shut up but that sometimes

they come out and walk abroad. They are all black, about two lines of an inch long, and three quarters of a line broad. Their body is distinguished into several plies or folds, and near their head they have three feet on each side, which have but two joints resembling those of a louse. When they move, their body is commonly upwards, with their mouth against the stone. They have a large head, somewhat flat and even, of the colour of a tortoise-shell, with some small white hair. Their mouth is also large, where may be seen four kinds of jaw-bones, lying crosswise, which they move continually, opening and shutting them like a pair of compasses with four branches. The jaws, on both sides of the mouth, are all black; the nether-jaw has a point like the sting of a bee, but uniform. They draw threads out of their mouth with their fore-feet, using that point to range them, and to form their shells of them. They have ten eyes, very black and round, which appear to be larger than a pin's head. There are five of them on each side of the head.

Besides these worms, I have found that mortar is eaten by an immense number of small creatures, of the size of cheese mites. These have but two eyes, and are blackish. They have four feet on each side pretty long. The point of their muzzle is very sharp, like that of a spider.

You may observe more of them in walls exposed to the south than in others. The worms that eat the stone live longer than those that eat the mortar, which scarcely live above eight days. I have observed all their parts with a good microscope, without which, and a great deal of attention, it is difficult to see them well.

Observations on Ants. By Dr. Edmund King.

There have occurred to my observation but three sorts of ants, commonly without wings; viz. very black, dark brown, and the third sort of nearly the colour usually called feuillemort.

Each kind have distinct habitations in their several banks, two [illegible] seldom or never being found together; and and if either of the other two sorts be put into the black ants' bank, it is worth observing what enmity there is between these little creatures, and with what violence the black ones will seize on the red, pinching them on the head with forceps or claws, till they have killed them, which done, they will carry them out of the field from their bank. But if you put black ants into a bank of the red, the black seem

to be so sensible of the strangeness of the place they are in, that there they will not meddle with the red, but as if they were frightened, and concerned for nothing but self-preservation, run away.

Upon opening these banks, I observe first a white substance, which to the bare eye looks like the scatterings of fine white sugar or salt, but very soft and tender; and if you take a bit of it, as big, perhaps, as a mustard-seed, and lay it on the object-plate of a good microscope, you may, by opening it with the point of a needle, discern many pure white and clear appearances in distinct membranes, all figured like the lesser sort of birds' eggs, and as clear as a fish's bladder. This same substance I find in the ants themselves, which I take to be the true ants' eggs; it being obvious that wherever this is uncovered, they make it their business to carry it away in their mouths to secure it, and will, after you have scattered it, lay it on a heap again with what speed they can.

I observe they lie in multitudes upon this spawn; and after a little time, every one of these small adherents is turned into a little vermicle, as small as a mite, hardly discerned to stir; but after a few days more you may perceive a feeble motion of flexion and extension, and they begin to look yellowish and hairy, shaped very like a small maggot; and so keeping that shape grow almost as large as an ant, and have every one a black spot on them.

Then they get a film over them, whitish and of an oval shape, for which reason I suppose they are commonly called ants' eggs, which yet, properly speaking, they are not. These are the chrysalids.

I have, to prevent mistakes, opened many of these vulgarly called ants' eggs, I mean the lesser sort, (for there are some as big as a wheat-corn, others less than a rye-corn,) and in some I find only a maggot, to appearance just such as was described before: in others I find a maggot beginning to put on the shape of an ant about the head, with two little yellowish specks where the eyes are designed: in others a further progress, and furnished with every thing to complete the shape of an ant, but wholly transparent, the eyes only excepted, which are then as black as black bugles.

But when they have newly put on this shape, I could never discern the least motion in any part of the little creature, the reason of which may perhaps be the weakness of their fibres; for after a little more time, when they begin to be brownish, they have strength to stir all their parts.

At last I met with some of these reputed eggs, which

having carefully opened, I took out of several of them every way perfect and complete ants, which immediately crept about among the rest, no way differing from many other ants, but by a more feeble motion of their limbs. And this I took for a clear demonstration of what I wished to know, that the film covers the maggot only while she is transforming into an ant, and till fit to shift for herself.

The black speck that is at one end of every such reputed ant's egg, I suppose to be cast out of the maggot in her transformation; since after it puts on the shape of an ant the speck is quite gone, and the whole body of the ant clear; since also this speck at the end of the said egg lies always close to the anus of the inclosed ant.

As to their care for their young, (by which I mean all the sorts and degrees aforesaid, from the spawn to the vulgarly called eggs, in every one of which you will find a young ant,) it is observable, how upon the breaking up of their banks they make it their business immediately to carry their young out of sight again, laying the several sorts of them in several places and heaps; which if you mingle again or scatter, you shall, laying but some bits of slate or the like in any place they may come to and get under, after a few hours, see all the vermicles and vulgarly called eggs laid in their several and distinct parcels under such pieces of slate, &c., provided the place be not so cold as to chill their limbs; which if it be, by being brought to the fire they will soon recover their strength, and fall to their business again of securing their little ones.

I have observed in summer, that in the morning they bring up those of their young (which are vulgarly called ants' eggs) towards the top of the bank; so that you may from ten in the morning until five or six in the afternoon find them near the top; especially about one, two, or three o'clock and later, if the weather be hot, when for the most part they are found on the south side of the bank, so that towards seven or eight at night, if it be cool or likely to rain, you may dig a foot deep before you can find them.

They know all the sorts of their young so well, that you cannot deceive them; though you may with fine sugar, salt, or the crums of very white stale bread, scattered in the mould where their first true eggs are (as I call them) be mistaken yourself, yet the ants will not, nor touch a bit of what is not their own offspring.

Experiments concerning the Relation between Air and Light in shining Wood and Fish. By Mr. Boyle.

On* putting a piece of shining rotten wood into the receiver of an air-pump, and the pump being set to work, we observed not, during the five or six first strokes, that the splendour of the included wood was lessened, but about the seventh it seemed to grow a little more dim, and afterwards, losing of its light more and more as the air was further pumped out, at length, about the tenth stroke, we could not perceive any light at all to proceed from the wood.

We let in the air again by degrees, and had the pleasure to see the seemingly extinguished light revive so fast, and perfectly, that it looked to us almost like a little flash of lightning, and the splendour of the wood seemed rather greater than before it was put into the receiver. On including the wood in a very small receiver of clear glass, it was found that in this the light would begin to grow faint at the second or third stroke, and at the sixth or seventh would quite disappear.

Having exhausted the receiver, till the wood quite disappeared, we stayed above a quarter of an hour in the dark, without perceiving that the wood had regained any thing of light, and then, on letting in the air, the wood presently recovered its light.

On placing a piece of red-hot iron properly within the receiver, and exhausting the air, the operation seemed not to have any effect on it as to alter its shining.

Having taken a stale and shining fish that was almost all over luminous, though much more in the belly and some parts of the head than elsewhere, and having suspended him in a conveniently shaped receiver, and having exhausted the receiver as much as usual, it appeared, indeed, especially towards the latter end of the operation, that the absence of the air considerably lessened, and in some places eclipsed the light of those parts that shone less strongly; but the belly appeared not much less luminous than before. On re-admitting the air, the light was perceived [illegible] as it were revived and increased, those parts of the fish [illegible] were scarce visible before, or shone but dimly, receiving presently their former splendour.

Having put into the receiver small pieces of rotten fish, that shone some of them more faintly and some of them more vividly in respect to one another, and having in a very small and clear receiver so far drawn off the air as to make

the included body disappear; after thus keeping out the air for about twenty-four hours, and then allowing it to re-enter in a dark place and late at night, upon its first admittance the fish regained its light.

Having put a piece of shining fish into a wide-mouthed glass, about half filled with fair water, and placed this glass in a receiver, the air was exhausted for a good while; it could not be perceived that either the absence or return of the air had any great effect upon the light of the immersed body.

Placing a very luminous piece of shining fish in the receiver, after exhausting it was kept there 48 hours, in which time its light gradually and wholly vanished; but on restoring the air it recovered its light again, as in the former instances.

The resemblances between burning coal and shining wood are as follow: — 1. Both live coals and shining wood are luminous by their own light. — 2. Both shining wood and burning coal require the presence of the air. — 3. Both shining wood and a burning coal having been deprived for a time of their light, by the withdrawing of the contiguous air, may recover it by presently letting in fresh air upon them. — 4. Both live coal and shining wood are easily extinguished by water and many other liquors.

Their differences are as follow: — 1. Although the light of the coal is readily extinguishable by compression, the wood is not affected by it. — 2. A live coal will in a very few minutes be totally extinguished by withdrawing the air; whereas shining wood immediately recovers its light if the air be admitted again. — 3. A live coal being put into a small close glass continues to burn only a very few minutes; but a piece of shining wood continues to shine for whole days. — 4. A coal as it burns emits a great deal of smoke or exhalations; but luminous wood does not. — 5. A coal in shining wastes at a great rate; but shining wood does not. — 6. Live coal is vehemently hot; whereas shining wood is not sensibly lukewarm.

Account by the celebrated Dr. Harvey, of Thomas Parr, who died in London at the Age of 152 Years and nine Months.

Parr was a poor countryman of Shropshire, whence he was brought to London by Thomas Earl of Arundel to be shown to Charles I.; and he died Nov. 14. 1635, after he had out-lived nine sovereigns, and during the reign of the tenth, at the age of 152 years and nine months.

Being opened after his death, his body was found very fleshy, and his breast hairy, and lungs not fungous. His heart was great, thick, fibrous, and fat. His viscera very sound and strong, especially the stomach; and it was observed of him that he used to eat often by night and day, though contented with old cheese, milk, coarse bread, small beer, and whey; and he ate at midnight a little before he died. His bowels were also sound, a little whitish without. His spleen very little, hardly equalling the bigness of one kidney. In short, all his inward parts appeared so healthy, that if he had not changed his diet and air, he might perhaps have lived a good while longer.

The cause of his death was imputed chiefly to the change of food and air; for leaving a clear, free air, he came into the thick air of London, and after a constant, plain, and homely country diet, was taken into a splendid family, where he fed high, and drank plentifully of the best wines, whereupon the natural functions of the parts of his body were overcharged, his lungs obstructed, and the habit of the whole body quite disordered, upon which there could not but soon ensue a dissolution.

His brain was found entire and firm; and though he had not the use of his eyes, nor much of his memory, several years before he died, yet he had his hearing and apprehension very well, and was able even to the hundred and thirtieth year of his age to do any husbandman's work, even threshing of corn. At 120 he married a widow.

Some Observations concerning the darting of Spiders. In a Letter to Mr. J. Ray.

All spiders that spin a thread (those which we call shepherds or long-legged spiders never do) produce these threads observable in the air in summer in such infinite quantities every where, especially towards September. I had exactly marked all the ways of weaving used by any sorts of them, and in those admirable works I had always observed that they still let down the thread they made use of, and drew it after them. At length, in close attending on one that wrought a net, I saw her suddenly in the mid-work to desist, and turning her tail into the wind, to dart out a thread with the same violence that water spouts out of a spring; this thread, taken up by the wind, was in a moment emitted some fathoms long, still issuing out of the belly of the animal;

by and by the spider leaped into the air, and the thread mounted her up swiftly.

After this first discovery, I made the like observation in almost all the sorts of spiders I had before distinguished, and I found the air filled with young and old, sailing on their threads, and undoubtedly seizing gnats and other insects in their passage; there being often as manifest signs of slaughter, as legs, wings of flies, &c. on these threads as in their webs below. Many of these threads that came down out of the air were not single, but snarled and had complicated woolly locks, now more now less; on these I did not always find spiders, though many times I had found two or three upon one of them; whereas when they first flew up, the thread was always single, or but little tangled, or thicker in one place than another. I observed them get to the top of a stalk or bough, or some such thing, where they exercise this darting of threads into the air, and if they had not a mind to sail, they either swiftly drew it up again, winding it up with their fore feet over their head into a lock, or break it off short, and let the air carry it away. This they will do many times together, and you may see those that have chains of these locks or snarled thread before them, and not yet taken flight.

Again, I found, that after the first flight, all the time of their sailing they made locks, still darting forth fresh supplies of thread to sport and sail by. It is further to be noted, that these complicated threads are much more tender than our house-webs.

In winter, about Christmas, I have observed them busied in darting; but few of them sail then, and therefore but single threads only are to be seen; and besides, the young ones only of last autumn's hatch are then employed, and it is more than probable that the great ropes of autumn are made only by the large ones, and upon long passages and summer weather, when great numbers of prey may invite them to stay longer up in the air.

Of the Eruptions of Mount Ætna.

The eruption took place on the 11th of March, 1669, about two hours before night, on the south-east side or skirt of the mountain, about 20 miles beneath the Old Mouth, and 10 miles from Catania. At first it was reported to advance three miles in 24 hours; but April 5. it scarce moved after the rate of a furlong a day; and at this degree of

progress it continued for 15 or 20 days after, passing under the walls of Catania a good way into the sea; but about the latter end of this month (April) and the beginning of May, it bent all its force against that city; and passed in divers places over the walls; but the chief fury fell on the convent of the Benedictines, having large gardens and other ground between them and the wall: which when it had filled up, it fell with all its force on the convent.

The matter which thus ran was nothing else but divers kinds of metals and minerals, rendered liquid by the fierceness of the fire in the bowels of the earth, boiling up and gushing forth like the water at the head of some great river; and having run in a full body for a good stone's cast or more, the extremities thereof began to crust and curdle, forming when cold those hard porous stones which the people call sciarri, having the nearest resemblance to huge cakes of sea-coal, full of fire. These came rolling and tumbling over one another, and where they met with a bank, would fill up and swell over, by their weight bearing down any common building, and burning whatever was combustible. The chief motion of this matter was forward, but it also dilated itself, as a flood of water would do on even ground.

About two or three o'clock at night we mounted a high tower in Catania, whence we had a full view of the mouth; which was a terrible sight. Next morning we would have gone up to the mouth itself, but durst not come nearer than a furlong off, for fear of being overwhelmed by a sudden turn of the wind, which carried up into the air some of that vast pillar of ashes, which to our apprehension exceeded twice the size of St. Paul's steeple in London, and went up in a straight body to a far greater height than it; the whole air being thereabout all covered with the lightest of those ashes blown off from the top of this pillar: and from the first breaking out of the fire till its fury ceased, being 54 days, neither sun nor star were seen in all that part.

About the middle of May we again went up to the mouth, where now without any danger of fire or ashes we could take a free view both of the old and new channel of the fire, and of that great mountain of ashes cast up. That which we guessed to be the old bed or channel was a three-cornered plot of about two acres, with a crust of sciarri at the bottom, and upon that a small crust or surface of brimstone. It was edged in on each side with a great bank or hill of ashes, and behind and at the upper end rose up that huge mountain of the same matter. Between those two banks the fire seems

to have had its passage. At the upper end in the nook upon a little hillock of crusted sciarri was a hole about 10 feet wide, whence probably the fire issued; and it might have had several other such holes, since either crusted over or covered with ashes. At the bottom of this hole the fire was seen to flow along, and below it was a channel of fire, beneath that surface of sciarri, which being cleft a-top for some space, we had an easy and deliberate view of the metal flowing along, whose superficies might be a yard broad, though possibly it carried a greater breadth underneath, the gutter sloping. What depth it had we could not guess: it was impenetrable by iron hooks and other instruments.

Some Inquiries concerning the Salt Springs and the Way of Salt-making at Nantwich in Cheshire, answered by WILLIAM JACKSON, *M. D*

1. WHAT is the depth of the salt springs?—The depths are various, in some places not above three or four yards; at Nantwich, the pit is full seven yards from the footing about the pit, which is guessed to be the natural height of the ground, though the bank be six feet higher, accidentally raised by accumulated rubbish or walling as they call it. In other places the springs lie much shallower; for in two places within our township the springs break up so in the meadows, as to fret away not only the grass, but part of the earth which lies like a breach at least half a foot or more lower than the turf of the meadow, and has a salt liquor oosing as it were out of the mud, but very gently.

2. What kind of country it is where the springs are, whether hilly, &c?—Generally a low ground, yet very full of eminences, and various risings, to distinguish it from being all meadow. We have also a peculiar sort of ground in this county and some adjacent parts, which we call mosses, they are a kind of moorish boggy ground, very stringy and fat: which serves us very well for turfs, cut out like great bricks and dried in the sun.

3. How strong the water is of salt?—Springs are rich or poor in a double sense; for a spring may be rich in salt, but poor in the quantity of brine it affords. Thus they have a rich brine in their chief pit at Middlewich, which yields a full fourth part of salt; yet this is so thrifty of its brine, that the inhabitants are limited to their proportions out of it, and their quantity is supplied out of pits that afford a weaker

brine. Our pit at Nantwich yields but a sixth part; but then it is plentiful.

4. What is the manner of their work?—Their manner of working is this: They have formerly boiled their brine in six leaden pans with wood-fire; upon which account they all claim their interest in it by the name of so many six leads walling; by which they each know their proportion; but in the memory of many they changed their six leads into four iron pans, something better than a yard square, and about six inches deep, still fitting the content of these to that of the six leads: and of late many have changed the four iron pans into two greater; and some wall but in one: but still the rulers gauge it to their old proportions.

An Account of a Halo seen at Paris: also on the Cause of these Meteors, and of Parhelias or Mock Suns. By M. Huygens.

This halo, or circle about the sun, was observed at Paris, March 12. 1667, about nine o'clock in the morning. The diameter was 44 degrees, and the breadth of its limb about half a degree. The upper and lower part were of a vivid red and yellow, with a little purple colour, but especially the upper; the red was within the circle. The other parts appeared but whitish and of little clearness. The space within the halo was a little darker than that about it, especially towards the parts that were coloured. Besides there was seen the portion of another great circle, which touched the halo above, and whose extremities were bent downward. This portion of a circle had also its colours like those of the halo, but fainter. The height of the sun, at the beginning of the observation, was about 46 degrees. There were in the air little clouds, which somewhat tarnished the blue colour of the sky, and lessened the brightness of the sun, which seemed as in an eclipse. The weather was cold, considering the season of the year, and it was affirmed for certain, that it had frozen the night before. This halo appeared in the same beauty and splendour of colours unchanged, from nine in the morning till about half an hour past ten; after which time it became fainter and fainter, till two o'clock in the afternoon, when it ended, after it had resumed a little more force some time before it disappeared.

Halos are formed by small round grains, made up of two parts, one transparent, the other opaque, the latter being inclosed in the former, as a cherry-stone is in a cherry; many have

seen hail formed after this manner, and some of these little grains, which swim up and down in the air between us and the sun, being less distant from the axis, which extends itself from the sun to our eye, than of a certain angle, do necessarily hinder the rays, which fall on them, from coming to our eyes; since the opaque kernel is the c[illegible]at there is behind every such grain a space of a conic[illegible]ure, in which the eye of the spectator being situated, cannot see the sun through that grain, though it may see it when posited elsewhere.

These arches usually touch a parhelion, because the same horizontal cylinders, which produce the arch, produce also that parhelion by means of their two round and transparent ends.

To make all these different effects of the cylinders manifest to the eye, M. Huygens produced one of glass, a foot long; and for the opaque kernel in the middle, a cylinder of wood, and the ambient space filled with water, instead of transparent ice: which cylinder being exposed to the sun, and the eye put in proper places, there were successively seen all those reflections and refractions above mentioned. Whence it might be concluded, that a great number of the like cylinders, although very small in comparison to that, being found in the air, and having the several postures that have been supposed, all the appearances of the parhelia and their circles must exactly follow.

Experiments about Respiration, by the Honourable Robert Boyle.

Nature having, as zoologists teach us, furnished ducks and other water-fowl with a peculiar structure of some vessels about the heart, to enable them, when they have occasion to dive, to forbear for a while respiring under water without prejudice, I thought it worth the trial, whether such birds would much better than other animals endure the absence of the air in our exhausted receiver.

We put a full grown duck into a receiver, of which she filled a third part or somewhat more, but was not able to stand in an easy posture in it; then pumping out the air, though she seemed at first to continue well somewhat longer than a hen in her condition would have done; yet within the space of one minute she appeared much discomposed, and between that and the second minute, her struggling and convulsive motions increased so much, that her head also hanging carelessly down, she seemed to be just at the point of death; from which we presently rescued her by letting in the air upon her.

Having procured a duckling, that was yet callow, we conveyed her into the same receiver wherein the former had been included, and observed, that, though for a while she appeared not much disquieted, whilst the air was pumping out of the glass, yet before the first minute was quite ended, she gave manifest tokens of being much disordered; and the operation being continued a while longer, she grew so much worse, that several convulsive motions which she fell into before a second minute was expired, obliged us to let in the air upon her, whereby she quickly recovered.

Considering that vipers are animals endowed with lungs, (though of a different structure from those of men, dogs, cats, birds, &c.) and that their blood is actually cold, I thought it might, upon both those accounts, be very well worth trying what effect the withdrawing and absence of the air would have upon animals so constituted.

We included a viper in a small receiver, and as we drew out the air, she began to swell, and afforded us these phenomena:— 1. It was a good while after we had left pumping, ere the viper began to swell so much as to be forced to gape, which afterwards she did.—2. That she continued, by our estimate, above 2½ hours in the exhausted receiver without giving clear proof of her being killed.—3. That after she was once so swelled, as to be compelled to open her jaws, she appeared slender and lank again, and yet very soon after appeared swelled again, and had her jaws disjoined as before.

We took a viper, and including her in the largest sort of small receivers, we emptied the glass very carefully, and the viper moved up and down within, as if to seek for air, and after a while foamed a little at the mouth, and left some of the foam sticking to the inside of the glass: her body swelled not considerably, and her neck less, till a considerable time after we had left pumping; but afterwards the body and neck grew prodigiously tumid, and a blister appeared upon the back. An hour and a half after the exhaustion of the receiver, the distended viper gave manifest signs of life; but we observed none afterwards.

To these experiments upon vipers, I shall add one made upon an ordinary harmless snake. We included such an animal, together with a gauge, in a pretty portable receiver, which being exhausted and well secured against the ingress of the air, was laid aside in a quiet place, where it continued from 10 or 11 o'clock in the forenoon till about nine the next morning; and then my occasions calling me abroad, I looked upon the snake; which though he seemed to be dead.

and gave no signs of life upon the shaking of the receiver, yet upon holding the glass a convenient distance from a moderate fire, he did in a short time manifest himself to be alive by several tokens, and even by putting forth his forked tongue. In that condition I left him, and by reason of several avocations, came not back upon him again till early in the afternoon of the next day, at which time he was grown past recovery, and his jaws, which were formerly shut, gaped exceedingly wide, as if they had been stretched open by some external violence.

The same considerations that induced me to make trials upon vipers, invited me also to make several upon frogs.

We took a large lusty frog, and having included her in a small receiver, we drew out the air, and left her not very much swelled, and able to move her throat from time to time, though not so fast as when she freely breathed before the exsuction of the air. She continued alive about two hours, that we took notice of, sometimes removing from the one side of the receiver to the other; but she swelled more than before, and did not appear by any motion of her throat or thorax to exercise respiration, but her head was not very much swelled, nor her mouth forced open. After she had remained there somewhat above three hours, perceiving no sign of life in her, we let in the air upon her, at which the tumid body shrunk very much, but seemed not to have any other change wrought in it; and though we took her out of the receiver, yet in the free air itself she continued to appearance dead. Nevertheless, to see the utmost of the experiment, having caused her to be laid upon the grass in a garden all night, the next morning we found her perfectly alive again.

We took a small frog, and having conveyed her into a very small portable receiver, began to pump out the air. At first she was lively enough, but when the air was considerably withdrawn, she appeared to be very much disquieted, leaping sometimes after an odd manner, as it were to get out of the uneasy prison, but yet not so, but that after the operation was ended, and the receiver taken off, the frog was perfectly alive, and continued to appear so near an hour, though the abdomen was very much, and the throat somewhat, extended, this latter part having also left that wonted panting motion that is supposed to argue and accompany the respiration of frogs. At the end of about 3½ hours, after the removal of the receiver from the pump, the air was let in; whereupon the abdomen, which, by that time was strangely swelled, did

not only subside, but seemed to have a great cavity in it; as the throat also proportionably had; which cavities continued, the frog being gone past all recovery.

It might assist us in making the more rational conjectures about the phenomena of divers of our experiments, if we knew what quantity of aërial substance is usually found in the liquors we employ about them, especially in that most common of them, water. And, therefore, though it be very difficult (if at all possible) to determine the proportion of the air that lurks in water with any kind of certainty, many circumstances making it subject to vary very much, yet to make the best estimate I easily could, where none at all that I know of has been hitherto made by any man, I considered that it might afford us some light, if we discovered at least what proportion as to bulk the air latent in a quantity of water would have to the liquor it came from, when the aërial particles should be gathered together into one place.

On pumping out the air, numerous bubbles disclosed themselves, ascending nimbly to the upper part of the glass, where they made a kind of froth or foam. This done, the pump was suffered to rest a while, to give the aërial particles lodged in the water time to separate themselves and emerge, which when they had done the pump was plied again, for fear some air should have stolen into so large a receiver. These vicissitudes of pumping and resting lasted for a considerable time, till at length the bubbles began to be very rare, and we weary of waiting any longer; soon after which the external air was let into the receiver, and it appeared somewhat strange to the spectators, that notwithstanding so great a multitude of bubbles as had escaped out of the water, I could not, by attentively comparing the place where the surface of the water rested at first with that where it now stood, discern the difference to amount to above a hair's breadth, if so much, and the chief operator in the experiment professed that, for his part, he could not perceive any difference at all.

Having had frequent occasions to observe how quickly those animals, whose blood is actually warm, did expire in our vacuum, and that even those animals with lungs, whose blood was actually cold, were not able to live any considerable time there, I thought it worth while, though extremely difficult to try, whether there might not be some ways yet unpractised, either to make such animals as nature endows with lungs live without respiration, or at least to bring such insects, and other animals, as can already live without air, to move also without it in our vacuum.

"We took a number of tadpoles, and put them with a convenient quantity of water into a portable receiver of a round form, and observed, that at the first exsuction of the air they rose to the top of the water, though most of them subsided again, till the next exsuction raised them. The receiver being exhausted, they continued restless, moving all of them in the top of the water, and though some of them seemed to endeavour to go to the bottom, and dived some part of the way, especially with their heads, yet they were immediately buoyed up again. Within an hour or a little more they were all motionless, and lay floating on the water; wherefore I opened the receiver, upon which the air rushed in, and almost all of them presently sunk to the bottom, but none of them recovered.

We took five or six caterpillars of the same sort, but I could not tell to what ultimate species the writers about insects referred them. These being put into a separate receiver of a moderate size, had the air drawn away from them, and carefully kept from returning. But notwithstanding this deprivation of air, I found them, about an hour after, moving to and fro in the receiver; and even above two hours after that, I could, by shaking the vessel, excite in them some motions, that I did not suspect to be convulsive. But looking upon them again some time before I was to go to bed, about 10 hours after they were first included, they seemed to be quite dead, and though the air was forthwith restored to them, they continued to appear so, till I went to bed; yet I thought fit to try, whether time might not at length recover them, and leaving them all night in the receiver, I found the next day, that three if not four of them were perfectly recovered.

We closed up divers ordinary flies, and a bee or wasp; all which, when the air was fully withdrawn, lay as dead, save that for a very few minutes some of them had convulsive motions in their legs. They continued in this state 48 hours, after which the air was let in upon them, and that not producing any signs of life in them, they were laid in the meridian sun, but not any of them seemed in any degree to recover.

We conveyed then a number of mites, together with the mouldy cheese they were bred in to nourish them, into three or four portable receivers (which were all of them very small) not much differing in size. As soon as ever one of the receivers was removed from the engine, I looked with great attention upon it; and though just before the withdrawing

of the air the mites were seen to move up and down in it, yet within a few minutes after the receiver was applied to the engine, I could discern in them no life at all, nor was any perceived by some younger eyes than mine, whereunto I exposed them. Nay, by the help of a double convex glass (that was so set in a frame as to serve me as a microscope on such occasions) I was not able to see any of them stir up and down.

The Manner of Spiders projecting their Threads. Communicated by Mr. John Ray.

I have seen spiders shoot their webs three yards long before they begin to sail; and then they will, as it were, fly away incredibly swift: which phenomenon somewhat puzzles me, as the air seldom moves a quarter so fast as they seem to fly. In general they project their threads single, without dividing or forking at all to be seen in them: sometimes they shoot the thread upward, and will mount up with it in a line almost perpendicular; and at other times, they project it parallel to the horizon; as you may often see by their threads that run from one tree to another, and likewise in chambers from one wall to another. I confess this observation at first made me think that they could fly, because I could not conceive how a thread could be drawn so parallel to the horizon between two walls or trees, as above mentioned, unless the spider flew through the air in a straight line.

They often fasten their threads in several places to the things they creep over: the manner is, by beating their tails against them as they creep along. By this frequent beating in of their thread among the asperities of the place where they creep, they either secure it against the wind, that it be not easily blown away, or else, while they hang by it, if one stick breaks another holds fast; so that they do not fall to the ground

An Account by Dr. Erasmus Bartholin, *on a Crystal-like Body, sent to him from Iceland.*

The inhabitants of Iceland and our own merchants inform us, that this kind of crystal is found in divers places of that country; but chiefly dug out of a very high mountain, not far from the bay of Roerfiord, which lies in 65 degrees latitude. That the mountain has its whole outside made up of this substance, without a necessity of digging deep for it. That

it is cut out by iron tools, in the size of a cubic foot, or more; and that out of its corners there is sometimes found grown a harder matter capable of cutting glass, of a figure different from that of the whole mass, and approaching to that of diamonds.

The whole body is rather clear than bright, of the colour of limpid water; but that colour, when it has been immersed in water and dried again, becomes dull. Hence it is, that in its native place the upper surface is darkish; because of the rains and snows fallen upon it. Sometimes there appear also some reflections of colours, as in the rainbow. The angles are not pointed alike, all the flat sides being obliquely inclined to one another. The opposite plains are parallel.

In this crystalline prism, two of the plain angles are always acute, and the two other obtuse; and never any of them is equal to the collateral angles of the inclinations.

The objects seen through it appear sometimes, and in certain positions of the prism, double: where it is to be noted, that the distance between the two images is greater or less, according to the different size of the prism, so that in thinner pieces this difference of the double image almost vanishes.

The object appearing double, both images appear with a fainter colour, and sometimes one part of the same species is obscurer than the other.

To an attentive eye, one of these images will appear higher than the other.

In a certain position the image of an object, seen through this body, appears but single, as through any other transparent body.

We have also found a position wherein the object appears sixfold.

If any of the obtuse angles of this prism be divided into two equal parts by a line, and the visual rays pass from the eye to the object through that line, or its parallel, both images will meet in that line, or in another parallel to it.

Whereas objects, seen through diaphanous bodies, are wont to remain constantly in the same place, in what manner soever the transparent body be moved, nor the image on the surface move except the object be moved; we have observed here, that one of the images is movable, the other remaining fixed; although there be a way also to make the fixed image movable, and the movable fixed in the same crystal; and another, to make both movable.

The movable image does not move at random, but always

about the fixed, which while it turns about, it never describes a perfect circle, but in one case.

Of the Abundance of Wood found under Ground in Lincolnshire.

THAT fenny tract, called the Isle of Axholme, lying part in Lincolnshire and part in Yorkshire, and extending a considerable way, has anciently been a woody country, as appears by the abundance of oak, fir, and other trees, frequently found in the moor, whereof some oaks are five yards in compass and sixteen yards long; others smaller and longer, with good quantities of acorns near them, lying somewhat above three feet in depth, and near their roots, which do still stand as they grew, viz. in firm earth below the moor. The firs lie a foot or 18 inches deeper, more in number than the oak, and many of them 30 yards long; one of them being, not many years since, taken up of 36 yards long besides the top, lying also near the root, which stood likewise as it grew, having been burnt and not cut down as the oak had been also. The number of these trees is reported by Mr. Dugdale, in his book on draining the Fens in England, to be so great, that the inhabitants have, for divers years last past, taken up many cart loads in a year.

Of the original overflowing of this woody level no account is given. Even Mr. Dugdale only says, that the depth of the moor evinces that it has been so for divers hundreds of years, since that could not grow to the thickness it is of in a few ages. The cause thereof he concludes to have been the muddiness of the constant tides, which, flowing up the Humber into the Trent, left in time so much filth, as to obstruct the currents of the Idle, Done, and other rivers, which thence flowed back, and overwhelmed that flat country.

Of the Stone Quarry near Maestricht.

THERE is an excellent quarry, within cannon-shot of Maestricht, on the very brink of the river Maese, lying in a hill, where there are about 25 fathoms of rock and earth over head; the length of the hill being of some miles, extending along the river towards Liege: and near Maestricht having in breadth some half or three quarters of a mile, but more farther off. This quarry has one entry towards the river, where carts can pass with great ease, and unload the stones on the brink of the river, the quarry within lying

parallel to the horizon or level, and elevated but very little above the river.

This quarry, which has almost undermined the whole hill, affords one of the most surprising prospects, when lighted with many torches, that one can imagine. For there are thousands of square pillars in large level walks, and those almost every where above 20, and in some places many more feet high, and all wrought with so much neatness and regularity, that one would think it had been made rather with curious workmanship for an under-ground palace, than that those pillars and galleries were made by quarriers, that did it only for getting stone to build above ground.

This quarry serves the people, that live thereabout, for a kind of impregnable retreat, when armies march that way. For being acquainted with all the ways in it, they carry into it whatsoever they would have safe, as well their horses and cattle, as their movable furniture, till the danger be over; there being so much room, that 10,000 people may shelter themselves in it.

Mathematical Principles of Light, Colours, the Rainbow, &c. By F. M. Grimaldi of Bologna.

Father Grimaldi first noticed the spots in the sun, and gave to those in the moon names that are still in use, denominating them after the most eminent astronomers and philosophers. He made numerous experiments in optics, and some discoveries, which were afterwards confirmed and extended by Newton. Grimaldi discovered the circumstance of the lengthening of the solar image, by a ray of light let in through a small hole, and refracted through a glass prism. He taught also that the rays are of different colours, and that opaque objects have no colour but what they receive from the rays of light. He discovered that property of the rays by which, when they pass near the edge of certain objects, though without touching, they are inflected or bent from their direct course, an effect which he termed the diffraction of light, and which Newton afterwards called inflection.

Further, he discourses of colours, and considers how light is changed into colour, sometimes by reflection alone, sometimes by refraction alone, sometimes without either and without the change of the medium, viz. by diffraction. He explains, also, how light, by the sole intrinsic modification of itself, passes sometimes into a colour that is commonly called apparent; where he explains, that the reason why light passes into an apparent colour, is not some determinate

angle at which the rays amongst themselves are inclined, but that that colour is produced by the intention and density of light.

He teaches, also, that to the vision of things permanently coloured, there are not required any intentional species transmitted from them, and contradistinct from light; but that the light which is diffused or at least reflected from things coloured is sufficient; yet with such a modification as is to be found in light apparently coloured, on which occasion many particulars are delivered concerning reflex vision, with an explication of that quære, how the place of the thing seen is perceived, &c.

To all which is added, that the modification of light, by which it is both permanently, and (so to speak) apparently coloured, or made sensible under the representation of colour, may not improbably be said to be a determinate and most finely furrowed undulation of the same, and a kind of tremulous diffusion, with a certain very subtle floating, whereby it does, in a peculiar way of application, affect the organ of vision; which is illustrated and confirmed by what is by philosophers taught of sound and hearing. Upon which it is inferred, that colours are not any thing permanent in visible things, not of themselves lucid, when they are not illuminated; but that they are the light itself, under some peculiar modification made sensible by the sight.

In a large discourse of the rainbow, its colours and their order, its circular figure, the concentric form of rainbows, &c. he concludes, that a rainbow, both primary and secondary, is generated from the solar rays, reflected and refracted by the drops of a falling cloud, so that the primary is represented by the rays that are once reflected within those drops; but the secondary, by the rays twice reflected, and which after a double refraction in both cases pass to the eye, placed in the axis of the rainbow.

A Letter of Mr. Isaac Newton to the Secretary, containing his New Theory of Light and Colours.

SIR,—To perform my late promise to you, I shall without further ceremony acquaint you, that in the beginning of the year 1666 I procured a triangular glass prism, to try therewith the celebrated phenomena of colours. For that purpose having darkened my chamber, and made a small hole in my window shuts, to let in a convenient quantity of the sun's light, I placed my prism at his entrance, that it might be thereby refracted to the opposite wall.

Comparing the length of this coloured spectrum with its breadth, I found it about five times greater; a disproportion so extravagant, that it excited me to a more than ordinary curiosity of examining from whence it might proceed. I could scarce think, that the various thickness of the glass, or the termination with shadow or darkness, could have any influence on light to produce such an effect; yet I thought it not amiss, first to examine those circumstances, and so tried what would happen by transmitting light through parts of the glass of divers thicknesses, or through holes in the window of divers sizes, or by setting the prism without, so that the light might pass through it, and be refracted before it was terminated by the hole; but I found none of those circumstances material. The fashion of the colours was in all these cases the same.

I then proceeded to examine more critically, what might be effected by the difference of the incidence of rays coming from divers parts of the sun; and to that end measured the several lines and angles belonging to the image. Its distance from the hole or prism was 22 feet, its utmost length 13¼ inches; its breadth 2⅝; the diameter of the hole ¼ of an inch; the angle, which the rays, tending towards the middle of the image, made with those lines in which they would have proceeded without refraction, was 44° 56′. And the vertical angle of the prism, 63° 12′. Also the refractions on both sides the prism, that is, of the incident and emergent rays, were as near as I could make them equal, and consequently about 54° 4′. And the rays fell perpendicularly upon the wall. Now subducting the diameter of the hole from the length and breadth of the image, there remains 13 inches the length, and 2⅜ the breadth, comprehended by those rays which passed through the centre of the said hole, and consequently the angle of the hole, which that breadth subtended, was about 31′, answerable to the sun's diameter; but the angle which its length subtended was more than five such diameters, namely, 2° 49′.

I took two boards, and placed one of them close behind the prism at the window, so that the light might pass through a small hole, made in it for the purpose, and fall on the other board, which I placed at about 12 feet distance, having first made a small hole in it also, for some of that incident light to pass through. Then I placed another prism behind this second board, so that the light, trajected through both the boards, might pass through that also, and be again refracted before it arrived at the wall. This done, I took the first

prism in my hand, and turned it to and fro slowly about its axis, so much as to make the several parts of the image, cast on the second board, successively pass through the hole in it, that I might observe to what places on the wall the second prism would refract them. And I saw, by the variation of those places, that the light tending to that end of the image, towards which the refraction of the first prism was made, did in the second prism suffer a refraction considerably greater than the light tending to the other end. And so the true cause of the length of that image was detected to be no other than that light consists of rays differently refrangible, which, without any respect to a difference in their incidence, were, according to their degrees of refrangibility, transmitted towards divers parts of the wall.

Light, therefore, is not similar, or homogeneal, but consists of difform rays, some of which are more refrangible than others: so that of those, which are alike incident on the same medium, some shall be more refracted than others, and that not by any virtue of the glass, or other external cause, but from a predisposition, which every particular ray has to suffer a particular degree of refraction.

As the rays of light differ in degrees of refrangibility, so they also differ in their disposition to exhibit this or that particular colour. Colours are not qualifications of light, derived from refractions, or reflections of natural bodies (as it is generally believed), but original and connate properties, which in divers rays are diverse. Some rays are disposed to exhibit a red colour, and no other; some a yellow, and no other; some a green, and no other; and so of the rest. Nor are there only rays proper and particular to the more eminent colours, but even to all their intermediate gradations.

There are two sorts of colours: the one original and simple, the other compounded of these. The original or primary colours are red, yellow, green, blue, and a violet-purple, together with orange, indigo, and an indefinite variety of intermediate gradations.

But the most surprising and wonderful composition was that of whiteness. There is no one sort of rays which alone can exhibit this. It is ever compounded, and to its composition are requisite all the aforesaid primary colours, mixed in a due proportion. I have often with admiration beheld, that all the colours of the prism being made to converge, and thereby to be again mixed as they were in the light before it was incident upon the prism, reproduced light, entirely and perfectly white, and not at all sensibly differing from a direct

light of the sun, unless when the glasses I used were not sufficiently clear: for then they would a little incline it to their colour.

Why the colours of the rainbow appear in falling drops of rain, is also from hence evident. For, those drops which refract the rays disposed to appear purple, in greatest quantity to the spectator's eye, refract the rays of other sorts so much less, as to make them pass beside it; and such are the drops on the inside of the primary bow, and on the outside of the secondary or exterior one. So those drops, which refract in greatest plenty the rays apt to appear red, towards the spectator's eye, refract those of other sorts so much more, as to make them pass beside it; and such are the drops on the exterior part of the primary, and interior part of the secondary bow.

I might add more instances of this nature; but I shall conclude with this general one, that the colours of all natural bodies have no other origin than this, that they are variously qualified to reflect one sort of light in greater plenty than another. And this I have experimented in a dark room, by illuminating those bodies with uncompounded light of divers colours. For, by that means, any body may be made to appear of any colour. They have there no appropriate colour, but ever appear of the colour of the light cast upon them, but yet with this difference, that they are most brisk and vivid in the light of their own day-light colour.

Account of the Rotation of a large permanent Spot in the Planet Jupiter, observed by Signor Cassini.

Among the spots of Jupiter, there is none so sensible as one that is situated between the two belts, which in the disk of Jupiter are usually seen extended from east to west; the largest of which is between the centre and the northern limb, and the narrowest is beyond the centre towards the southern limb. This spot is always adhering to the southern belt, its diameter is about the tenth part of that of Jupiter; and at the time that its centre is nearest to that of Jupiter, it is distant from it about the third part of the semidiameter of that planet.

Signor Cassini, after he had made many observations of this spot during the summer of the year 1665, found that the period of its apparent revolution is nine hours and 56 minutes. By the calculation he made in six years, it is found to have made, in respect of the earth, at least 5294 revolutions, each

of nine hours, 55 minutes, 58 seconds, compensating one revolution by another, and at most 5295 revolutions of nine hours, 55 minutes, 51 seconds; forasmuch as he was assured of the preciseness of one mean revolution to one eighth of a minute, which will be verified by future observations.

Some Observations about Shining Flesh, made by Mr. Boyle.—

Mr. Boyle observed a neck of veal to shine in as many as 20 places, though not all alike, as rotten wood or stinking fish do. When all these lucid parts were surveyed at once, they made a very splendid show, so that applying a printed paper to some of the more luminous spots, he could plainly read divers letters of the title. But notwithstanding the vividness of this light, it did not yield the least degree of heat to the touch: and applying to the most shining place a sealed weather-glass, the tinged spirit of wine was not observed to be sensibly affected; and notwithstanding the great number of lucid parts, not the least degree of stench was perceivable to infer any putrefaction.

One of the luminous parts, which proved to be a tender bone, and of the thickness of a half-crown piece, appeared to shine on both sides, though not equally; and the part of the bone whence this had been cut off, was seen to shine, but not near so vividly as the part taken off did before. It yielded no luminous juice, or moist substance, as the tails of glow-worms do: upon compressing a piece of the luminous flesh between two pieces of glass, its light was not extinguished; and putting a luminous piece into a crystalline phial, and pouring on it a little pure spirit of wine, and shaking them together, in about a quarter of an hour or less, the light was vanished. But water could not so easily destroy this light; for putting one of the pieces into a china cup, almost full of cold water, the light did not only appear through that liquor, but above an hour after it was vigorous enough not to be eclipsed by being looked on at no great distance from a burning candle. On conveying one of the larger luminous pieces into a small receiver, the pump was plied in the dark, and on the gradual removal of the air, there was perceived a gradual diminution of the light, though it never quite disappeared, as the light of rotten wood and glow-worms were observed to do; but by the hasty increase of light, that disclosed itself in the veal upon admitting the air into the

exhausted receiver, it appeared that the decrement, though but slowly made, had been considerable.

A luminous piece of it included in a phial, after three days shone as vigorously as ever: the fourth day its light was also conspicuous, so that it could be seen even in the day-time, in a dark corner of the room; but before the ensuing night the light began to decay, and the offensive smell to grow somewhat strong; which seems to argue, that the disposition, by which the veal became luminous, may very well consist, both with its being, and not being, in a state of putrefaction, and, consequently, is not likely to be derived from the one or the other.

Observations on the Nature of Snow. By Dr. GREW.—

IF Aristotle and Descartes, &c. who have written of meteors, and amongst them of snow, have not yet given a full account of it, it will not be needless to enquire further of it. He that will do this, will do it best, not by the pursuit of his fancy in a chair, but with his eyes abroad; where if we use them well fixed, and with caution, and this in a thin, calm, and still, snow, we may by degrees observe, 1st, with M. Descartes and Mr. Hook, that many parts of snow are of a regular figure; for the most part, as it were, so many little rowels or stars of six points; being perfect and transparent ice, as any we see on a pool or vessel of water. On each of these six points are set other collateral points, and those always at the same angles as are the main points themselves. Next, among these irregular figures, though many of them are large and fair, yet from these taking our first item, many others, alike irregular, but much smaller, may likewise be discovered. Again, among these not only regular, but entire parts of snow, looking still more warily, we shall perceive that there are divers others, indeed irregular, yet chiefly the broken points, parcels, and fragments of the regular ones. Lastly, that besides the broken parts, there are some others which seem to have lost their regularity, not so much in being broken, as by various winds, first gently thawed, and then frozen into little irregular clumps again.

From hence the true notion and external nature of snow seems to appear, viz. that not only some few parts of snow, but originally the whole body of it, or of a snowy cloud, is an infinite mass of icicles regularly figured; that is, a cloud of

vapours being gathered into drops, the said drops forthwith descend; on which descent, meeting with a soft freezing wind, or at least passing through a colder region of air, each drop is immediately frozen into an icicle, shooting itself forth into several points on each hand outward from its centre, but still continuing their descent, and meeting with some sprinkling and intermixed gales of warmer air, or in their continual motion and waftage to and fro touching upon each other, some are a little thawed, blunted, frosted, clumpered, others broken, but the most clung in several parcels together, which we call flakes of snow.

It being known what snow is, we perceive why, though it seems to be soft, yet it is truly hard, because true ice; seeming only to be soft, because on the first touch of the finger on any of its sharp edges or points, they instantly thaw; otherwise they would pierce our fingers like so many lancets. Why again, though snow be true ice, and so a hard and dense body, yet very light, because of the extreme thinness of each icicle in comparison of its breadth. Also how it is white, not because hard, for there are many soft bodies white; but because consisting of parts all of them singly transparent, but being mixed together appear white, as the parts of froth, glass, ice, and other transparent bodies, whether soft or hard.

Thus much for the external nature of snow; let us next a little enquire into its essential nature. Now if we would make a judgment of this, I think we may best do it by considering what the general figure of snow is, and comparing the same with such regular figures as we see in divers other bodies. As for the figure of snow, it is generally one, viz. that which is above described: rarely of different ones, which may be reduced chiefly to two generals, circulars and hexagonals, either simple or compounded together. More rarely, either to be seen of more than six points; but if so, then not of 8 or 10, but 12. Or in single shoots, as so many short slender cylinders, like those of nitre. Or by one of these shoots, as the axle-tree, and touching upon the centre of a pair of pointed icicles, joined together as the two wheels. Or the same hexagonal figure, and of the same usual breadth, but continued in thickness or profundity.

Some Observations made by a Microscope contrived by M. Leuwenhoek, in Holland.

The mould upon skin, flesh, or other things, has been by some represented to be shot out in the form of the stalks of vegetables, so as that some of those stalks appeared with round knobs at the end, some with blossom-like leaves. But I observe that such mould shoots up first with a straight transparent stalk, in which stalk is driven up a globous substance, which for the most part places itself at the top of the stalk, and is followed by another globule, driving out the first either sideways or at the top; and that is succeeded by a third and more such globules; all which make up at last one great knob on the stalk, a hundred times thicker than the stalk itself. And this knob indeed consists of nothing else than of many small roundish knobs, which being multiplied, the large knob begins to burst asunder, and then represents a kind of blossoms with leaves.

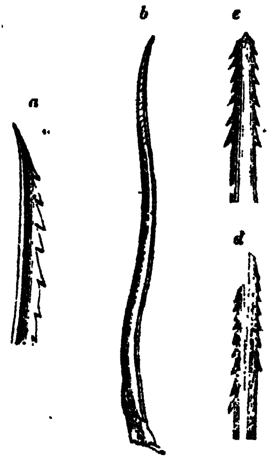
The sting of a bee I find of a different form than has been described by others. I have observed in it two other stings, that are lodged within the thickness of the first sting, each having its peculiar sheath.

Further, I observe, on the head of a bee before, two artus or limbs with teeth, which I call scrapers, conceiving them to be the organs with which the bee scrapes the waxy substance from the plant. Besides, I find two other limbs, each having two joints, which I call arms, with which I believe this insect performs its work and makes the combs. There is also a little body which I call the wiper, being rough, and exceeding the other limbs in thickness and length, by which I am apt to believe the bee wipes the honey substance from the plant. All which five limbs the bee, when at work, lays in a curious manner close under her head, in very good order.

As to the eye of the bee, which I have taken out of the head, exposing its innermost part to the microscope, I find, that the bee receives her light just with the same shadow as we see the honey-combs; whence I collect that the bee works not by art or knowledge, but only after the pattern of the light received in the eye.

In a louse I observe, indeed, as others have done, a short tapering nose with a hole in it, out of which that insect, when it will draw food, thrusts its sting, which, to my eye, was at least five and twenty times less than one single hair

But I find the head every where else very close round about, and without any such sutures as some have represented it. The skin of the head is rough, resembling a skin that has many dents in it. In the two horns I find five joints, others having marked but four. One claw of her foot is of the structure of that of an eagle, but the other of the same foot stands out straight and is very small; and between these two claws there is a raised part or knob, the better to clasp and hold fast the hair.



In the engraving fig. *a* shows part of the sting taken out of the sheath and drawn a little sideways; whence it is, that the crooks or barbs do not show so large nor sharp as indeed they are.

Fig. *b* represents the whole sting, taken out of the sheath, and with its back, which is without barbs, turned to the eye. The upper part of the sting is closed round about, and hollow within, and the lower part is open.

In fig. *c* both the stings are seen, as they lie together before, close against the sheath, yet is one of them a little higher than the other; and forasmuch as there is yet seen a little of the sheath, here both the stings seem to be one, furnished on both sides with barbs.

Fig. *d*. Both the stings in part out of their sheath, yet one stands a little higher out of the case than the other. Thus they are found to lie in their sheath when they are at rest.

As to the motion of these stings, I conceive it to be thus made: first the bee draws her sheath with its stings out of the body, and endeavours to thrust it as far as she can into the body she would sting, together with one of the stings, which at that time she draws out of the case; which sting, when she is drawing back again, but it not being able by reason of the barbs to return, she pulls the sheath and the other sting deeper into the body. Now it is that she uses her other sting, which she then thrusts also into the body as deep as she can, and then endeavours to pull that back also; by which pulling back she thrusts her sheath and first sting yet deeper into the body; and this she continues so long

till she gets both the stings and the sheath, as far as to the thick part of the sheath, into the body.

An Attempt to prove the Motion of the Earth from Observations made by ROBERT HOOK.

THE ingenious author of this attempt, having considered with himself, that the grand controversy about the earth remains yet undetermined, and finding there was no better means left for human industry to decide it but by observing, whether there be any sensible parallax of the earth's orbit among the fixed stars, did thereupon resolve to employ himself in making some observations concerning so important a point in astronomy. His method, which he gives an account of, is to observe, by the passing of some considerable star near the zenith of some place, whether such a star does not at one time of the year pass nearer to the zenith, and at another farther from it.

Accordingly he affirms to have actually made four observations; by which, he says, it is manifest, that there is a sensible parallax of the earth's orbit to the star in the dragon's head, and consequently a confirmation of the Copernican system against the Ptolemaic and Tychonic. At the end of the explication he mentions some things, which he looks upon as very remarkable, occurring in those observations; one of which was, that in the day-time, the sun shining very clear, he observed the bright star in the dragon's head to pass by the zenith as distinctly and clearly as if the sun had been set; which he esteems to have been the first time that the stars were seen when the sun shone very bright; that tradition, of seeing the stars in the day with the naked eye out of a deep well or mine, being by him judged a mere fiction, a thing he had deemed impossible.

Lastly, he promises that he will explain to the curious a system of the world, differing in many particulars from any yet known, but answering in all things to the common rules of mechanical motions; which system he here declares to depend on three suppositions: 1. That all celestial bodies whatsoever have an attraction or gravitating power towards their own centres, whereby they attract, not only their own parts, and keep them from flying from them, as we may observe the earth to do; but also all other celestial bodies that are within the sphere of their activity. 2. That all

bodies whatsoever, that are put into a direct and simple motion, will so continue to move forward in a straight line till they are by some other more effectual power deflected and bent into a motion that describes some curve line. 3. That these attractive powers are so much the more powerful in operating, by how much the nearer the body acted on is to their own centres.

Microscopical Observations made by M. Leuwenhoek. —

I have observed by the microscope, that blood consists of small round globules driven through a crystalline humidity or water. I have likewise observed some of the sweet milk of cows, and find that also to be made up of small transparent globules, carried in the same manner as in the blood through a clear liquor.

I observed the hair of an elk, and found it wholly to consist of conjoined globules, which by my microscope appeared so manifestly to me, as if they could be handled; and therefore having so clearly seen those globules, I assure myself, that the growth and increment of hair is made by the protrusion and driving on of globules. This hair of the elk I find to be within much hollower, than that of men or of other animals.

Again, I also observed a nail of my hand, and found it likewise to be made up of globules, not doubting but that it also grows from globules protruded.

Having formerly spoken of the louse, her sting, &c I cannot here omit to say something of what I have seen within that creature. I have several times put a hungry louse upon my hand, to observe her drawing blood from thence, and the subsequent motion of her body, which was thus: the louse having fixed her sting in the skin, and now drawing blood, the blood passes to the fore part of the head in a fine stream, and then it falls into a larger round place, which I take to be filled with air. This large room being, as to its fore part, filled about half full with blood, then propels its blood backward, and the air forward again: and this is continued with great quickness, while the louse is drawing the blood; except that at times she stops a little, as if she were tired, and recollects herself; a motion like that, it seems, which is in the mouth of a sucking infant: from thence the blood passes in a fine stream into the midst of her

head, that being also a large round place, where it has the same motion. Hence it passes in a subtile stream to the breast, and thence into a gut, which goes to the hindmost part of the body, and with a curvity bends a little upwards again. In the breast and gut the blood is, without intermission, moved with great force, and especially in the gut; and that with such strong beatings downwards, and with such a retrocourse and contraction of the gut, that a curious eye cannot but admire the motion.

Microscopical Observations concerning Blood, Milk, Bones and the Brain, &c. By M. Leuwenhoek.

The small red globules in the blood are heavier than the crystalline liquor in which they are carried; because, soon after the blood is let out of the veins, those globules gradually subside towards the bottom; and consisting of soft fluid corpuscles, many of which lie on one another, they unite close together, by which conjunction the blood under its surface alters its colour, and becomes dark, red, or blackish. The red globules of the blood I reckon to be 25,000 times smaller than a grain of sand.

I have observed the tooth of a cow, and found it made up of transparent globules, which I can see very perfectly. The same I have observed in ivory or elephants' teeth. And I have no doubt but that all white bones do consist of transparent globules. I am of opinion, that all things which appear white to our eyes are made up of nothing but transparent particles lying one upon another, such as snow, white paper, linen, white stones, white wood, scum, beaten glass, beaten rosin, sugar, salt, &c.

The brains of a cow being viewed, I found the white substance of it to be made up also of very fine globules. As to the marrow of the back-bone, I found that also to consist of very subtile globules. Having divers times observed the flesh of a cow, I found it to consist of very slender filaments, lying by each other, as if woven into a film. I have also viewed several filaments which were beset with globules. These I judged to be blood, and that, pricking our body with a pin without hitting a vein, the bloody globules issued from between these filaments; but this I leave to further consideration. Mean time I have with a pin's point severed these filaments from one another, and found the single ones so fine, that any of them seemed to me 25 times thinner and finer

than a hair. Having exposed them to my microscope, I saw, to my wonder, that they were made up of very small conjoined globules, which in smallness seemed to surpass all the rest.

The uppermost skin of our body consists of round parts or small scales. And I fancy that the continual growth of this cuticula is made in this manner; that the humidity issues forth from between all those round particles or scales lying close upon each other, and not through pores as many have taught. Like a close and well twisted cable, upon which pouring continually some water, this water will pass through the whole cable, and oose out at the end; not passing through any pores, but making its way about and between the filaments of the cable, and so getting out beneath. And the coarser or more consistent matter cleaves to the body, and so makes the uppermost skin; which thus grows on from beneath, and is worn off from above: and the more transparent these particles are, the whiter is our skin. And the like manner of growing I have formerly said to take place in plants, only with this difference, that when the superficies of a moist globule, which is driven out of the plant, is become somewhat stiff, the moisture is then propelled out of the upper end of the plant, and that by a continual succession. Which kind of progress of growing I apprehend may in some manner be seen in the pith of wood, in cork, in the pith of membranes, as also in the white of a quill.

I have often viewed the sweat of men and horses, and found it consisted of a crystalline moisture, in which I saw many transparent globules moving with some odd larger parts, which I judged to be scalings off from the cuticula.

I formerly announced, that I imagined I had seen hair as made up of united globules, and to have also observed elephants' hair consist of the like. I cannot omit now to communicate, that since then I have seen such globules, not only in human hair and horse hair, but also frequently in the wool of sheep; and, further, that the root of the hair pulled out of the eye-brows consists altogether of the like globules. Having pulled out of an elephant's tail a black hair, and cut transversely from it a thin scale, I exposed it to my microscope, which represented in the thick of that hair about a hundred little specks, somewhat whitish, and in each speck a black point, and in some few of those black points a little hole; and this air consisted of united globules, which yet I

thought I should have found larger in this thick hair of so bulky a beast than indeed they were.

I lately viewed some blood in which there was much of the crystalline liquor; and going into the open air in high wind I saw, to my great delight, continually, and without any other motion but that of the wind, the red globules blown about, and as if each globule had yet a second motion, and that about its axis.

I have heretofore viewed the fat of sheep and cows, and showed to several of the curious, that it is made up of globules joined together, which appeared to my eye as large as ordinary hail-stones. And I have lately observed, that each globule of fat consists of more than a thousand small globules. Yet I am apt to believe, that those that have not seen the globules in blood, hair, bone, &c. will not satisfy themselves about seeing them in fat, because of their extraordinary minuteness.

An Account given by Denys Papin *to show that the Rain and Snow Waters are sufficient to make Fountains and Rivers run perpetually.*

Some persons say, that a cubic inch of water yields, in 24 hours running, 144 muids (the name of a French measure holding 280 French pints), others say it yields but 70 of that measure. But I have reason to believe that it yields 83 of this measure; and it is known that a vessel of eight cubic feet holds one muid of water.

This being supposed, it follows, that a vessel which contains 83 muids of water is able to furnish in 24 hours as much as will make an inch of water run continually. So that, if a conservatory should hold 3578 muids of water, it would furnish for a whole year a sufficient quantity to make an inch of water run constantly. And if it were as large again, it would furnish two running, and so on in proportion. Then for the measure of the rain and snow water, I have found that, taking the medium, we have 19 inches and $2\frac{1}{3}$ lines in depth.

I have observed the river Seine, in its course from the source of it unto Ainay le Duc, where a rivulet enters that swells it. And this I shall take for the subject of the examination I intend to make. — The course, then, of this river, from its spring to the said Ainay le Duc, is about three leagues long, and the sides of its course extend themselves on the right and left about two leagues on each side, where

there are other little rivers that run another way: and since these rivulets require water to maintain them, as well as the Seine, I shall count but half that space of the sides, and say, that the place where the Seine passes, has, from its source to Ainay le Duc, three miles long, and two miles broad.

If a reservoir were made of this size, it would be six leagues square in surface, which being reduced to fathoms, it would, according to the measure above mentioned, make 31¼ millions of fathoms in surface. In this conservatory imagine, that during a whole year, there has fallen rain to the height of 19 inches 2⅓ lines, as before said; this height of 19 inches and 2⅓ lines gives nearly 281 millions of muids of water. All this water thus collected, in the quantity just now expressed, is that stock which is to serve to make the river run for a whole year, from its source to the place before named, and which must also serve to supply other occasions and losses, such as are the feeding of trees, herbs, vapours, and extraordinary swellings of the river while it rains, and the deviations of the water running another way.

This river, then, sends away within its banks in a year no more than about 36½ millions of muids of water. But taking this quantity out of the 281 millions that are in the conservatory above described, there will remain yet above 188 millions of muids, which amounts to almost five times as much, and which serves to furnish for the losses, diminutions, and other wastes, above noticed. So that there needs but the sixth part of the rain and snow water that falls in a year, to make a river run continually through the whole year.

Restoration of Animal Life. By Dr. PECHLIN.*

HE relates that extraordinary example of a Swedish gardener, lately alive, who some years ago endeavouring to help another who was fallen into the water under the ice, fell into it himself to the depth of 18 Swedish ells; where afterwards he was found standing upright with his feet on the ground, and whence they drew him up, after he had remained there for the space of 16 hours, wrapping him about close with linen and woollen clothes, to keep the air from too sud denly rushing upon him, and then laying him in some warm place, and rubbing and rolling him, and at length giving him some very spirituous liquor to drink; by all which he was at length restored to life, and brought to the queen-mother of Sweden, who gave him a yearly pension, and showed him as a prodigy to divers persons of quality; the same thing

being also confirmed by the famous Dr. Langelot, who himself received the relation in Sweden so well attested, that nothing, says our author, can be required more to prove a historical truth.

Observations on a Subterranean Fire in a Coal-mine near Newcastle. By Dr. Lucas Hodgson.

This subterraneous fire bears no analogy to other volcanoes: it increases or decreases according to the subject it feeds on, which is for the most part a day-coal, as they call it, that is, the upper seam of the coal, next exposed to the air, so that you may light a candle at it in some places, in others it is some fathoms deep, according as the day-coal heightens or deepens. There is no sal ammoniac, nor any thing like it to be found, except at the fire. There being such a mixture of the steams of sal ammoniac and sulphur rising together in most places, it is hard to distinguish them; for though the flowers of brimstone seem to rise first, yet there is commonly a crust of sal ammoniac under them.

The milky substance is only found where the sal ammoniac and sulphur are totally gone, and the acid part, or aluminous spirit of that white mass, will also fly off by the increase of the fire, leaving a caput mortuum, dry, styptic, and as hard as a stone; yet a pound of this mass, before the fire press too much upon it, will nearly afford by solution, &c. half a pound of tolerable crystalline alum. The neighbouring soil differs little from other grounds with us, having neither common salt nor nitre in it. I have industriously observed the springs that are near the fire, and find none of them that give the least suspicion of sal ammoniac. The water that runs from the adjacent collieries is vitriolic, giving as deep a tincture with galls as Scarborough Spa, and differs in nothing from the ordinary waters of collieries. The other springs are of ordinary use, containing no mineral salts in them.

But I hope you will cease to wonder, that coal should produce a volatile salt by the action of fire, seeing I have gathered sal ammoniac from a burning brick-kiln, where nothing but clay and coal is burnt together; and I hope none will expect the volatile salt in the sal ammoniac from common clay. The reason that first prompted me to seek this salt there, was, that the smell of the kiln did somewhat resemble that of the subterranean fire. There is also a sort of mineral called slate, which is partly coal, partly alum-stone, partly marcasite, which being laid up in heaps and burnt, is used

for hardening the coal-ways: on these heaps, whilst burning, I have often gathered both brimstone and sal ammoniac.

Observations on Animalcula seen in Rain, Well, Sea, and Snow Water; as also in Pepper Water. By M. Leuwenhoek

In the year 1675, I discovered very small living creatures in rain-water, which had stood but few days in a new earthen pot, glazed blue within. This invited me to view this water with great attention, especially those little animals appearing to me ten thousand times less than water-fleas, or water-lice, which may be perceived in the water with the naked eye.

The first sort I several times observed to consist of 5, 6, 7, or 8 clear globules, without being able to discern any film that held them together, or contained them. When these animalcula, or living atoms, moved, they put forth two little horns, continually moving. The space between these two horns was flat, though the rest of the body was roundish, sharpening a little towards the end, where they had a tail, near four times the length of the whole body, of the thickness, by my microscope, of a spider's web; at the end of which appeared a globule of the size of one of those which made up the body. These little creatures, if they chanced to light on the least filament or string, or other such particle, were entangled therein, extending their body in a long round, and endeavouring to disentangle their tail. This motion of extension and contraction continued a while; and I have seen several hundreds of these poor little creatures, within the space of a grain of gross sand, lie fast clustered together in a few filaments.

I also discovered a second sort, of an oval figure; and I imagined their head to stand on the sharp end. These were a little larger than the former. The inferior part of their body is flat, furnished with several extremely thin feet, which moved very nimbly. The upper part of the body was round, and had within 8, 10, or 12 globules, where they were very clear. These little animals sometimes changed their figure into a perfect round, especially when they came to lie on any dry place. Their body was also very flexible; for as soon as they struck against any the smallest fibre or string, their body was bent in, which bending presently also jerked out again.

There was a fourth sort, which were so small that I was not able to give them any figure at all. These were a thousand

times smaller than the eye of a large louse. These exceeded all the former in celerity. I have often observed them to stand still as it were on a point, and then turn themselves about with that swiftness, as we see a top turn round, the circumference they made being no larger than that of a small grain of sand, and then extending themselves straight forward, and by and by lying in a bending posture.

I perceived in pure water, after some days, more of those animals, as also some that were somewhat larger. And I imagine, that many thousands of these little creatures do not equal an ordinary grain of sand in bulk; and comparing them with a cheese-mite, which may be seen to move with the naked eye, I make the proportion of one of these small water-creatures to a cheese-mite, to be like that of a bee to a horse; for, the circumference of one of these little animals in water is not so large as the thickness of a hair in a cheese-mite.

In another quantity of rain-water exposed for some days to the air, I observed some thousands of them in one drop of water, which were of the smallest sort that I had seen hitherto. And in some time after I observed, besides the animals already noted, a sort of creatures that were eight times as large, of almost a round figure; and as those very small animalcula swam gently among each other, moving as gnats do in the air, so did these larger ones move far more swiftly, tumbling round as it were, and then making a sudden downfall.

In the water of the river of Maese I saw very small creatures of different kinds and colours, and so small, that I could very hardly discern their figures; but the number of them was far less than of those found in rain-water. In the water of a very cold well in the autumn, I discovered a great number of living animals very small, that were exceedingly clear, and a little larger than the smallest I ever saw. In sea-water I observed, at first, a little blackish animal, looking as if it had been made up of two globules. This creature had a peculiar motion, resembling the skipping of a flea on white paper, so that it might very well be called a water-flea; but it was far less than the eye of the water-flea.

Having put about one third of an ounce of whole pepper in water, and it having lain about three weeks in the water, to which I had twice added some snow-water, the other water being in great part exhaled, I discerned in it with great surprise an incredible number of little animals, of divers kinds, and among the rest, some that were three or four times as

long as broad; but their whole thickness did not much exceed that of the hair of a louse. They had a very pretty motion, often tumbling about and sideways: and when the water was let to run off from them, they turned round like a top; at first their body changed into an oval, and afterwards, when the circular motion ceased, they returned to their former length. The second sort of creatures discovered in this water were of a perfect oval figure, and they had no less pleasing or nimble a motion than the former; and these were in far greater numbers. There was a third sort, which exceeded the two former in number, and these had tails like those I had formerly observed in rain-water. The fourth sort, which moved through the three former sorts, were incredibly small, so that I judged, that if 100 of them lay one by another, they would not equal the length of a grain of coarse sand; and according to this estimate, 1,000,000 of them could not equal the dimensions of a grain of such coarse sand. There was discovered a fifth sort, which had near the thickness of the former, but almost twice the length.

I thus order my division of the water, and the enumeration of the animalcula: I suppose that a drop of water equals a pea in bulk; and I take a little quantity of water of a round figure, as large as a millet-grain; this I reckon to be the $\frac{1}{91}$ part of a pea: for when the axis of a millet-seed makes 1, that of a pea makes $4\frac{1}{2}$: whence it follows, that the grain of a millet is at least the $\frac{1}{91}$ part of a pea, according to the received rules of mathematicians. This small quantity of water I gather up into a very slender glass-pipe, dividing by this means that little water into 25 or 30 parts, of which I observe one part after another, and show the same to others.

Other spectators, as well as myself, judged that in $\frac{1}{30}$ part of the water, equalling the bulk of a millet-seed, he saw more than 1000 living animals: but they wondered much more, when I said I saw it in two or three kinds of much smaller animals besides, which did not appear to them, because I saw them by another microscope, which I still reserve to myself alone.* Hence it is manifest, that if in the $\frac{1}{30}$ part of one millet-seed there are seen 1000, there may be seen 30,000 in one such whole seed, and consequently in a drop of water, which is 91 times larger than such a seed, there may be seen 2,730,000. For, $4\frac{1}{2} \times 4\frac{1}{2} \times 4\frac{1}{2} = 91\frac{1}{8}$; and $91 \times 30,000 = 2,730,000$.

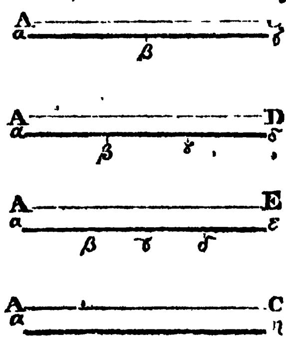
Otherwise, I compare the quantity of the water to the bulk of a grain of sand; in which quantity of water I doubt not

at all that I see more than 1000 animalcula. Now if the axis of a grain of sand be 1, the axis of a drop of water is at least 10, and consequently a drop is 1000 times larger than that sand, and therefore 1,000,000 living creatures in one drop of water. In which computation I rather lessen than heighten the number.

Last winter, when the severe cold had killed the little creatures, observing the water thawed by the warmth of the room in which it had stood for a whole day with a fire in it, I found after 24 hours were elapsed, and another time after 17 hours were passed, that some living animals appeared again in that water.

On the trembling of Consonant Strings. By Dr. Wallis. —

Sir, — I have thought fit to notice a discovery that has been made here. Whereas it has been long since observed, that if a viol or lute string be touched with the bow or hand, another string on the same or another instrument not far from it, if an unison to it or an octave, or the like, will at the same time tremble of its own accord. The cause of it having been formerly discussed by many, I do not now enquire into. But add this to the former observation, that not the whole of that other string trembles, but the several parts severally, according as they are unisons to the whole, or the parts of that string which is so struck. For instance, supposing A C to be an upper octave to $\alpha\gamma$, and therefore an unison to each half of it, stopped at β; now if, while $\alpha\gamma$ is open, A C be struck, the two halves of this other, that is, $\alpha\beta$ and $\beta\gamma$, will both tremble, but not the middle point at β. Which will easily be observed, if a little bit of paper be lightly wrapped about the string $\alpha\gamma$, and removed successively from one end of the string to the other. In like manner, if A D be an upper twelfth to $\alpha\delta$, and consequently an unison to its three parts equally divided in β, γ. Now if, $\alpha\delta$ being open, A D be struck, its three parts, $\alpha\beta$, $\beta\gamma$, $\gamma\delta$, will severally tremble, but not the points β, γ; which may be observed in like manner



as the former. In the same way, if A E be a double octave to $\alpha\epsilon$, the four quarters of this will tremble, when that is struck, but not the points β, γ, δ. So if A G be a fifth to $\alpha\eta$, and consequently each half of that stopped in D, an unison to each third part of this stopped in $\gamma\epsilon$, while that is struck, each part of this will tremble severally, but not the points γ, ϵ; and while this is struck, each of that will tremble, but not the point D. The like will hold in less concords, but the less remarkably as the number of divisions increases.

Of an unusual Meteor. By Dr. WALLIS.

AN unusual meteor was seen Sept. 20th, 1676, about seven o'clock; which, though it seemed very low, was seen in most parts of England much at the same time, and much in the same manner. I hear of it from divers persons who saw it in Oxford, Northamptonshire, Gloucestershire, Worcestershire, Somersetshire, Hampshire, Kent, Essex, London, &c.

In the dusk of that evening, there appeared a sudden light, equal to that of noonday; so that the smallest pin or straw might be seen lying on the ground. And above in the air was seen, at no great distance as was supposed, a long appearance as of fire; like a long arm, with a great nob at the end of it, shooting along very swiftly; and at its disappearing seemed to break into small sparks or parcels of fire, like as rockets and such artificial fire-works in the air usually do. It was so surprising and of so short continuance, that it was scarcely seen by any who did not then happen to be abroad: its duration, by report, less than half a minute. It seems surprising that it was seen in most parts of England, and at or near the same time; which argues, that either it was higher than the observers imagined, or else that it had a very swift motion.

On the Motion of Light. By M. ROMER.

PHILOSOPHERS have been endeavouring for many years to decide, by some experiment, whether the action of light be conveyed in an instant to distant places, or whether it requires time. M. Romer of the Royal Academy of Sciences has devised a way for this purpose, taken from the observations of the first satellite of Jupiter, by which he demonstrates, that for the distance of about 3000 leagues, which is nearly equal to the diameter of the earth, light needs not one second of time.

The necessity of this new equation of the retardment of light is established by all the observations that have been made in the Royal Academy, and in the Observatory for the space of eight years; and it has been lately confirmed by the emersion of the first satellite observed at Paris, the 9th of November last, at 5 o'clock, 35^m 45^s at night, 10 minutes later than it was to be expected, by deducing it from those that had been observed in the month of August, when the earth was much nearer to Jupiter: which M. Romer had predicted to the said Academy from the beginning of September.

Mr. Leuwenhoek concerning the Carneous Fibres of a Muscle, and the Cortical and Medullary Part of the Brain.

I took the flesh of a cow; which I cut asunder with a sharp knife, and using a microscope I severed before my eyes the membrane from it; by which I plainly saw that fine membrane or film, in which these carneous fibres lie interwoven. Observing these membranes more narrowly, I saw that they wholly and only consist of small threads running through each other; of which some appeared to be 10, 20, and even 50 times thinner than a hair. Having taken off these membranes from the carneous filaments, I saw very clearly these carneous threads, which in this piece of flesh were as thick as a hair on the hand. Where they lay rather thick on each other, they appeared red; but the thinner they were spread the clearer they showed.

I have used several methods of viewing the particles of these carneous filaments, and have always found that they are composed of globular parts. I have also divided before my eye, into many small parts, very small pieces of these carneous filaments, which pieces were several times smaller than a grain of sand; and I have observed, besides, that, when the flesh is fresh and moist, and its globules are pressed or rubbed, they dissolve and run together, in appearance like an oily or thick waterish matter; which globules appeared so small, that 1,000,000 of them would not make one grain of gravel sand. The general figure of these globules were roundish, but a little compressed, like a multitude of very small blown bladders, lying on a heap.

I have examined, also, that membrane of the brain, which is called pia mater, and found that it is permeated by very many small veins, besides those which with the naked eye we see on the brain, especially having first separated the thin mem-

brane from the brain, under which I have seen small veins of an admirable and incredible fineness, and as far as I was able to discern they consist of exceedingly thin filaments. I have further observed, that the said veins which thus run through the thin membrane disseminate their ramifications through the brain, after the manner as vines lying upon the earth shoot roots into the ground; imagining the brain to be like the earth, and the veins like the roots in it.

Proceeding to the parts of the brain itself, I must still say of them that they consist of no other parts but globules; but where the brain lay spread very thin, cut through with a knife, as if they had been separated from each other, there they appeared like a very clear matter resembling oil. Continuing my observations, not only of the brains of beasts but also of fishes, and particularly of a cod-fish, and representing it very plainly to my eye, I saw that the said oleaginous matter had not been caused by the knife, but was a matter by itself, wherein the aforesaid globules lay.

Among the said globules, of which the brain partly consists, I have seen blood globules, which may plainly be discerned from the brain-globules, especially by the perfect roundness which the blood globules had. These blood globules I imagined came out of the sanguineous vessels which run through the brain, and had been cut in pieces by the knife.

I have also observed the spinal marrow of a calf, pullet, sheep, and cod-fish; which I have found to consist of no other parts than those of the brain; yet with this difference, that besides the globules in the brain, there lay in the spinal marrow a great number of shining oleaginous globules of divers sizes, some of them 50 times larger than others; and those also very soft and fluid. These spinal marrows were also furnished with exceedingly thin and manifold small veins or vessels; and besides these very small veins, there ran up and down along these spinal marrows brown filaments, thinner than the hair of the head. I perceived that each filament was not one single vessel by itself, but that each of them consisted of divers very small threads or vessels, lying by each other, between which threads there lay very clear vessels of the fineness of a single silk-worm thread.

The Manner of hatching Chickens at Cairo. By Mr. JOHN GRAVES.

THE people begin in the middle of January to heat the ovens, employing every morning 100 kintars, or pounds'

weight of camel's, or of buffalo's dung, and the like quantity at night, till the middle of February. About which time the ovens are so hot, that a person can hardly endure to lay his hand on the walls. After this, they put the eggs into the ovens, to hatch the chickens, which they continue successively till the end of May.

The eggs are first put upon mats in the lower ovens which are on the ground; 7000 or 8000 eggs in number, and laid only double, one upon another. In the ovens above these lower, the fire is made in long hearths or little channels, having some depth to receive the fire, from whence the heat is conveyed into the lower ovens before mentioned. The eggs which are directly under these hearths, lie treble one upon another; the rest, as was said, only double. At night when they renew the fires in the hearths above mentioned, they then remove the eggs that were directly undermost, lying treble one upon another, in the place of those which lay on the sides only double, and these being now removed, they lay treble under the hearth, because the heat is there greater than on the sides where the eggs are only double. These eggs continue in the lower ovens fourteen days and nights; afterwards they remove them into the upper ovens, which are just over the lower. In these, there being now no more fire used, they turn all the eggs four times every day or twenty-four hours. The fire in the upper ovens, when the eggs are placed in the lower, is thus proportioned: The first day, the greatest fire. The second, less than the first. The third, less again. The fourth, more than the third. The fifth, less. The sixth, more than the fifth. The seventh, less. The eighth, more. The ninth, without fire. The tenth, a little fire in the morning. The eleventh, they shut all the holes with flax, &c. making no more fire; for if they should, the eggs would break. They take care, that the eggs be no hotter than the eye of a man, when they are laid upon it, can well endure. The twenty-first or twenty-second day the chickens are hatched, which the first day eat not; the second they are fetched away by women, who give them corn, &c.

When the chickens are hatched they put them into the lower ovens, which are covered with mats. Under the mats is bran, to dry the chickens; and upon the mats straw, for the chickens to stand on.

The master of the ovens has a third part of the eggs for his cost and pains, out of which he is to make good unto the owners, who have two thirds in chickens for their eggs, such as may happen to be spoiled or miscarry.

Account of the Tin Mines in Cornwall. By Dr. CHRISTOPHER MERRET.

THE stones, from which tin is wrought, are sometimes found a foot or two below the surface of the earth, but most usually between two walls or rocks, and are commonly of an iron colour, of little or no affinity with the tin, and lying in a vein or load between four and eighteen inches broad. Sometimes there is a rich and fat metal; sometimes hungry and starved; sometimes nothing but a drossy substance, neither purely earth, nor stone, nor metal; but a little resembling the rejected cinders of a smith's forge; and where this is found the miners judge the metal to be ripe.

The pits are 40, 50, or sometimes 60 fathoms deep and more. The load being very rich and good, above that is about 10 fathoms from the grass; and below that there is a large cavity, containing nothing but air, for many fathoms deep. This cavity lies between hard stony walls, about six or nine inches asunder.

Tin is usually incorporated with the stone, or is found in it. They break every individual stone: and if there be any blackness in the stones, of this black stuff the tin is produced. Sometimes it is as it were mixed with a small gravelly earth; sometimes white, but for the most part red. From this earth it is easily separated by bare washing; but from the stone not without much stamping. This gravelly tin they distinguish from that which is gathered from the stones, calling it pryan tin, and is but about half the richness of the other. They have another sort of ore, called mundic ore. Being mixed together, the mundic may be easily known by its glittering, yet deep brownness. The mundic is said to nourish the tin; and yet they say where much mundic is found there is little or no tin: and where there is little or none of that, much and good tin is found. Certain it is, if there be any mundic left in melting the tin, it does it much prejudice, making it less ductile. For tin without it will easily bend any way; but mixed with it, becomes very brittle, and will crack and break.

This mundic seems to be a kind of sulphur. Fire only separates it from the tin, and evaporates it into smoke. Little sprigs or boughs being set in the chimney, the smoke gathers upon them into a substance, which they call poison, and think it is a kind of arsenic: which being put into water, easily dissolves, and produces very good vitriol. The water in which it is dissolved soon changes small iron rods put into

it. When they burn it to separate it from the tin, it sends forth a very loathsome and dangerous stench.

Besides the fore-mentioned stones, &c. found in tin mines, and incorporated with the tin; there occurs a spar, mixed also with this metal, as it is commonly with lead and copper. This appears frequently of a shiny whitish substance: and casts a white froth on the water in washing it. When 'tis taken out of the earth it is soft and fattish, but soon after grows somewhat hard. The miners call it white spar.

The Cornish diamonds, so called, lie intermixed with the ore, and sometimes on heaps; some of them large enough to have a coat of arms engraven on them; and are hard enough to cut glass. Some of them are of a transparent red, and have the lustre of a deep ruby. These diamonds seem to me to be but a finer, purer, and harder sort of spar; for they are both found together, as on St. Vincent's rocks near Bristol.

The working of the ore is performed in this manner: The stones, first previously beaten, are brought to the stamping-mill. They are so disposed, as that by degrees they are washed into a latten-box with holes, into which the stampers fall: by which means they are beaten pretty small, and by the water continually passing through the box, the ore through its weight, falls close by the mill, and the parts not metalline, which they call causalty, are washed away by the water; and thus the first separation is made. They then take that which falls close by the mill, and so dispose it in the said mill, that the water may once more drive it, to make a better separation of the causalty. Next they dry it in a furnace on iron plates, and then grind it very fine in a crazing-mill, with stones common in the hills of that country. After this they rewash it as before, and then dry it a little, and so carry it to the furnace, called a blowing-house, and there melt and cast it.

Of Red Snow seen at Genoa. By Sig. Sarotti.

On St. Joseph's day, on the mountains called Le Langhe, there fell on the white snow, that lay there before, a great quantity of red, or if you please, of bloody snow. From which, being squeezed, there came a water of the same colour.

Observations in Congo. By MICHAEL ANGELO DE GUATTINI.—

IN the kingdom of Congo there are serpents 25 feet long, which will swallow at once a whole sheep. The manner of taking them is thus: when they lie to digest what they have eaten, they stretch themselves out in the sun, which the blacks seeing kill them. And having cut off their head and tail, and embowelled them, they eat them; and usually find them as fat as hogs. There are here a great number of ants, and so large, that the author reports that being one day sick in his bed he was forced to order himself to be carried out of his room for fear of being devoured by them. As it often happens to those of Angola, where may be seen in the morning the skeletons of cows devoured by these animals in one night.

On the Structure of Teeth and other Bones, also of Hair. By Mr. ANTONY LEUWENHOEK.

HAVING some time since applied a glass, esteemed a good one, to observe the structure of the teeth and other bones, they then seemed to consist of globules. But since then, having drawn out one of my teeth, and for further observation applied better glasses than the former, it has plainly appeared that the whole tooth was made up of very small, straight, and transparent pipes. 600 or 700 of these pipes put together exceed not the thickness of one hair of a man's beard. In the teeth of a cow, the same pipes appear somewhat larger, and in those of a haddock somewhat less. I have also observed part of the shin-bone of a calf, six or eight weeks old, in which the pipes are less straight than in a tooth; and sometimes there seemed to be several lesser pipes joining together, so as to constitute a larger one.

The grain of ivory appears like the fibres or threads of a muscle, running in parcels, decussatim, and under and over each other reciprocally, and so making up one piece of platted work.

I have formerly, also, with others, examined the structure of hair; and we agreed that it consisted wholly of globules. But not being satisfied without further enquiry, I took the hair of my beard after it had been shaved the first, second, third, and fourth days, and observed, that the little particles which we saw through the common microscopes, which yet were very good, and which appeared round, were indeed irregular, and lay very closely pressed one upon another. Of

these particles consist the outer parts or cuticle of the hair. One of these hairs I met with, which seemed rare, being on the one side convex, on the other somewhat concave, and looking like two hairs continuous or growing together. I examined the roots of several hairs plucked out of my hand, nostrils, eye-lid, eye-brow, &c. and clearly saw that the whole root, except the cuticle, consisted of little strings, which I suppose to be veins or vessels, appearing like a common tree with all its roots.

Account of the Salt Springs and Salt-making at Droitwich. By Dr. THOMAS RASTELL.

THE depth of the springs is various: some rise on the top of the ground which are not so salt as others: those that are in the pits we make use of are various also. The great pit, which is called Upwich pit, is 30 feet deep, in which are three distinct springs rising in the bottom. The pit is about 10 feet square; the sides are made with square elms, jointed in at the full length, which I suppose is occasioned by the saltness of the ground, which appears to me to have been a bog; the surface of it is made of ashes.

In the great pit at Upwich, we have at once three sorts of brine, which we call by the names of first-man, middle-man, and last-man; these sorts being of different strengths. The brine is drawn by a pump; that which is in the bottom is first pumped out, which is that we call first-man, &c. A quart measure of this brine weighs 29 ounces troy, but of distilled water only 24 ounces. This brine yields above a fourth part salt; so that four tuns of brine make above one tun of salt. The two other sorts less, or 28 ounces. And the pit yields 450 bushels of salt per day. In the best pit at Netherwich, a quart of brine weighs 28 ounces and a half; this pit is 18 feet deep, and four feet broad, and yields as much brine every 24 hours as makes about 40 bushels of salt. The worst pit at Netherwich is of the same breadth and depth as the former; a quart of brine out of which weighs 27 ounces, and yields as much brine daily as makes about 30 bushels of salt.

The vats we boil the brine in are made of lead, cast into a flat plate, five feet and a half long, and three feet over; then the sides and ends beaten up, and a little raised in the middle, which are set upon brick-work, called ovens, in which is a grate to make the fire on, and an ash-hole which we call a trunk. In some seals are six of these pans, in some five, some four, some three, some two. In each of these pans is boiled at a time as

much brine as makes three pecks of white salt. For clarifying the salt we should have little need, were it not for dust accidentally falling into the brine. The brine of itself being so clear that nothing can be clearer. For clarifying it we use nothing but the whites of eggs; of which we take a quarter of a white, and put it into a gallon or two of brine, which being beaten with the hand, lathers as if it were soap, a small quantity of which froth put into each vat, raises all the scum, the white of one egg clarifying 20 bushels of salt; by which means our salt is as white as any thing can be; neither has it any ill savour, as that salt has that is clarified with blood. For granulating it we use nothing at all; for the brine is so strong of itself, that unless it be often stirred, it will make salt as large grained as bay-salt. I have boiled brine to a candy height, and it has produced clods of salt as clear as the clearest alum, like Isle of May salt; so that we are necessitated to put a small quantity of rosin into the brine, to make the grain of the salt small.

Besides the white salt above spoken of, we have another sort, called clod-salt, which adheres to the bottoms of the vats, and which after the white salt is laded out, is digged up with a steel picker. This is the strongest salt I have seen, and is most used for salting bacon and neats' tongues; it makes the bacon redder than other salt, and makes the fat eat firm: if the swine are fed with mast, it hardens the fat almost as much as if fed with pease, and salted with white salt. It is very much used by country-women, to put into their runnet-pots, esteeming it better for their cheese. These clods are used to broil meat with, being laid on coals; but we account it too strong to salt beef with, as it takes away too much of its sweetness. There is a third sort of salt, called knockings, which candies on the stales of the barrow, as the brine runs from the salt after it is laded out of the vats: this salt is most used for the same purposes as the clod salt, though it is not altogether so strong. There is also a fourth sort, called scrapings, being a coarse sort of salt that is mixed with dross and dust, that cleaves to the tops of the sides of the vats; this salt is scraped off the vats when we reach them, that is, when we take the vats off the fires to beat up the bottom; and is bought by the poor sort of people to salt meat with. A fifth sort is pigeon salt; which is nothing but the brine running out through the crack of a vat, and hardens to a clod on the outside over the fire. Lastly, the salt loaves are the finest of the white salt, the grain of which is made something finer than ordinary, that it

may the better adhere together, which is done by adding a little more rosin, and is beaten into the barrows when it is laded out of the vat.

Our salt is not so apt to dissolve as Cheshire salt, nor as that salt that is made by dissolving bay-salt and clarifying it, which is called salt upon salt, as appears by our long keeping it without any fire.

Letter of Mr. Leuwenhoek, *containing an Account of the vast Numbers of Animals in Melts of Fish.*

Viewing the melt of a live cod-fish, I found the juices which ran from it full of small live animals, incessantly moving to and fro. I have also viewed the melt of pikes or jacks, and found an incredible number of small animals and I judge that there were at least 10,000 of these creatures in the size of a small sand. These were smaller than those I observed in beasts, but their tails longer and thinner.

How vast and almost incredible the number of these creatures is, you may somewhat the better conceive by the calculation which I have hereunto annexed. I have formerly said that in a quantity of the juice of the melt of a male cod-fish, of the size of a small sand, there are contained more than 10,000 small living creatures with long tails; and considering how many such quantities, viz. of the size of a sand, might be contained in the whole melt, I was of opinion, that the melt of one single cod-fish contained more living animals than there were living men at one time upon the face of the earth.

An Account of Okey-hole, and several other Subterraneous Grottos and Caverns in Mendip-hills. By Mr. John Beaumont, *Jun.*

On the south side of Mendip-hills, within a mile of Wells, is a famous grotto, known by the name of Okey-hole, much resorted to by travellers.

At first entering this vault, you go upon a level: but advancing farther into it, you find the way rocky and uneven, sometimes ascending and sometimes descending. The roof in the highest part is about eight fathoms from the floor, and in some places it is so low that a man must stoop to pass through. Its width is also various; in some parts it is about five or six fathoms, in others not above one or two; it extends itself in length about 200 yards.

" At the farther part of this cavern there rises a good stream of water, large enough to drive a mill, which passes all along one side of the cavern, and at length slides down about six or eight fathoms between the rocks, and then pressing through the clefts of them, discharges itself into a valley. This river within the cavern is well stored with eels, and has some trouts in it, which must of necessity have been engendered there, and not come from without, there being so great a fall near the entrance. In a dry summer I have seen a number of frogs all along the cavern, to the farthest part of it, and other little animals in some small cisterns of water there. Before arriving at the middle of this vault, you find a bed of very fine sand, which is much used by artists to cast metals in. On the roof, at certain places, hang multitudes of bats, as usual in all caverns whose entrance is upon a level, or somewhat ascending or descending.

The next cavern of note lies about five miles from this, on the south-west part of Mendip-hills, near a place called Chedder, famous for cheese; from this place you may pass up a narrow valley about a mile in length, being bounded with precipitous rocks on the east and west, some of a very considerable height. To enter into this cavern, before you reach half way this valley, you must ascend about 15 fathoms on those rocks which bound it to the east. This cavern is not of so large extent as the former, neither has it any thing peculiar in it. These two caverns have no communication with the mines.

It is generally observed, that wherever mines of lead-ore are, there caverns of various kinds and situations are found. The most considerable in Mendip-hills is a cavern in a hill called Lamb. First a perpendicular shaft descends about 10 fathoms, then you come into a leading vault, which extends itself in length about 40 fathoms; it runs not on a level, but descending, so that when you come to the end of it you are 23 fathoms deep by a perpendicular line: the floor of it is full of loose rocks: its roof is firmly vaulted with lime-stone rocks, having flowers of all colours hanging from them, which present a most beautiful object to the eye, being always kept moist by the distilling waters In some parts the roof is about five fathoms in height, in others so low that a man has much ado to pass by creeping; the width is mostly about three fathoms. This cavern crosses many veins of ore. About its middle, on the east side, lies a narrow passage into another cavern, which runs between

40 and 50 fathoms in length. At the end of the first cavern there opens another large one.

I have been in many other caverns upon Mendip-hills. The frequency of caverns on those hills may be easily guessed at, by the frequency of swallow-pits, which occur there in all parts, and are made by the falling in of the roofs of caverns; some of these pits being of a large extent, and very deep; and sometimes our miners, sinking in the bottom of these swallows, have found oaks 15 fathoms deep in the earth.

An Account of several curious Discoveries about the Internal Texture of the Flesh of Muscles, of strange Motions in the Fins, and the Manner of the Production of the Shells of Oysters, &c. By M. Leuwenhoek.

Formerly I have stated, that musculous flesh, viewed with an ordinary microscope, I conceived them to be composed of globules. I now find that they are not globules but rimples. For on examining beef muscles, I found them to be made up of small strings lying close joined together one by another; which were so small that 50 of them, laid one by another, would not make the breadth of the 22d part of an inch, and if supposed a 20th, leaving two for the thickness of the membrane that inclose them, there will be found 1000 of such strings lying one by another to make the breadth of an inch, and consequently 1,000,000 of them in a square inch.

In some of my late observations I took notice, that about 100 of these muscular strings lying by each other were wrapped round, and enclosed with a membrane, which made a muscular chord. At another time I observed in the muscles of an ox's tongue three such muscular chords, each enwrapped with its distinct membrane, whose ends when cut across would be covered by a sand no larger than the 100th part of an inch; whence we may conceive there may be about 5000 of such muscular chords in a square inch.

I took the season when oysters came to us in a short time from England, and observed, with admiration, what an extraordinary motion the beard of the oyster made; and although I took some very minute parts of it, many of which would not together make out the size of a sand, yet these parts, so broken, had such a motion as was inconceivable; for I imagined that such a small part represented to me a shrimp with its continual moving pattens, and others like a lobster. And one might have sworn that it was no part of the beard of the oyster, but an animal of itself, notwithstanding the contrary

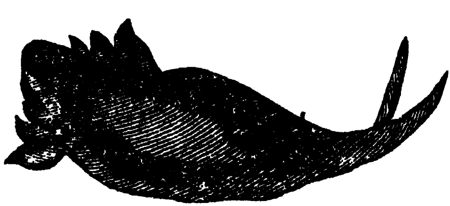
appeared; for such a part of the beard made no progressive motion, and remained in its motion lying in one place so long time, that when my sight failed me with looking, I was forced to leave it; and besides the fibres, which in so small a part seemed pattens or paws, had the same motion with the parts of the whole beard.

I observed the shell of an oyster, and found it all made up of plates laid in great numbers one over another, always larger and larger; so that the increase of the oyster shell is caused by the addition of a new lamen or plate in the shell: which last new made plate exceeds the rest in magnitude. These laminæ seem to be made up of small pipes, which are much interwoven But that which gave me most satisfaction was, that when each of these laminæ was arrived at its full size, then from the small pipes of the laminæ were put forth minute laminæ, which are not white like the rest, but of a brown colour, and constituted of globules.

Description of a monstrous Animal cast out of the Stomach by Vomit. By Dr. L*ISTER*, *of York.*

THE patient imagined he drank it the last summer in pond-water. This is certain, he had about his stomach and right side a most exquisite and tormenting pain, for at least four months last past, which many times threw him into horrors and chilness, ague-like; and, indeed, when he vomited this up, he was the sickest man I ever saw not to die; he also voided blood by stool several days, and now I believe he will recover, though his pains are not wholly ceased.

This animal was about four inches long, and in the thickest place three inches about: it had three fins of a side, all near the head, and the upper pair most exactly and elegantly figured, as is described; all these fins were thick and fleshy; but the forked tail was finny and transparent, and to be extended; it was placed horizontally, not as that of most, if not all, small fish, and even newts and tadpoles, in which particular it differs from them all, as well as in the fleshiness of the fins.



Description of Pen-park Hole, in Gloucestershire. Communicated by Sir Robert Southwel.

There is a place in Gloucestershire called Pen-park, about three miles from Bristol, and above three from the Severn, wherein some miners for lead discovering a large hole in the earth, one Captain Sturmy, a warm inquisitive seaman, who has written a large folio on Navigation, would needs descend, and his narrative was as follows: —

On the 2d of July, 1669, I descended by ropes affixed at the top of an old lead-ore pit, four fathoms almost perpendicular, and from thence three fathoms more obliquely, between two great rocks, where I found the mouth of this spacious place, from which a miner and myself lowered ourselves by ropes, 25 fathoms perpendicular, into a very large place, which resembled to us the form of a horse-shoe; for we stuck lighted candles all the way we went, to discover what we could find remarkable. At length we came to a river or great water, which I found to be 20 fathoms broad, and eight fathoms deep. As we were walking by this river, 32 fathoms under ground, we discovered a great hollowness in a rock, some 30 feet above us, so that I got a ladder down to us, and the miner went up the ladder to that place, and walked into it about 70 paces, till he just lost sight of me, and from thence cheerfully called to me, and told me he had found what he looked for, a rich mine.

Here are abundance of strange places, the flooring being a kind of a white stone, enamelled with lead-ore, and the pendant rocks were glazed with saltpetre, which distilled upon them from above, and time had petrified After some hours' stay there we ascended without much hurt, except scratching ourselves by climbing the sharp rocks. But for four days after my return I was troubled with a violent head-ache, which I impute to my being in that vault.

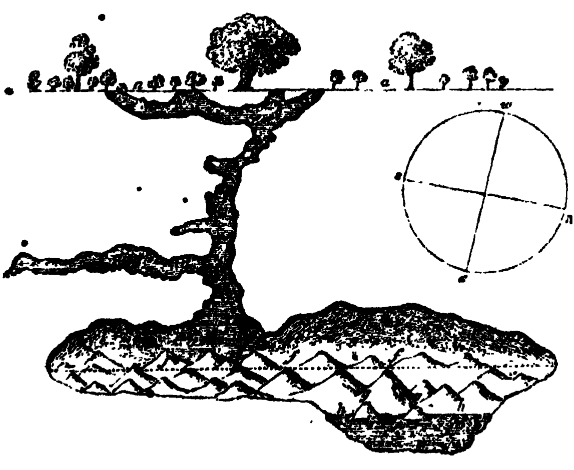
Captain Sturmy falling from his head-ache into a fever, and dying; what from his death, and the opinion of an evil spirit, nobody was willing to have any more to do with the said hole from that time to this.

But Captain Collins, commander of the Merlin yacht, coming to the Severn, and visiting Sir Robert Southwel near Kingroad, Sir Robert told him how the story of this hole had amused the country; and that the narrative had formerly been sent to his Majesty and the Royal Society; and that there wanted only some courage to find out the bottom of it. The Captain resolved to adventure, and on the 18th and 19th

of September, 1682, he took several of his men, with ropes and tackling fitting to descend, with lines to measure any length or depth, also with candles, torches, and a speaking-trumpet. What he found does much lessen the credit and terror of this hole, as will appear by the figure he took thereof, and the description following: —

It is down the tunnel from the superficies to the opening of the cavity less than 39 yards. Then the hole spreading into an irregular oblong figure, is in the greatest length 75 yards, and in the greatest breadth 41 yards; from the highest part of the roof to the water was then 19 yards; the water was now in a pool, at the north end, being the deepest part: it was in length 27 yards, in breadth 12, and only five yards and a half deep; two rocks appeared above the water all covered with mud, but the water was sweet and good; there was a large circle of mud round the pool, and far up towards the south end, which showed that the water has at other times been six yards higher than at present.

The tunnel or passage down was somewhat oblique, very ragged and rocky; in some places it was two yards wide, and in some three or four, but nothing observable therein, save here and there some of that spar which usually attends the mines of lead ore. In the way, 30 yards down, there runs in, southward, a passage of 29 yards in length, parallel to the superficies above; it was two or three yards high, and commonly as broad, and alike rocky as the tunnel, with some appearances of spar, but nothing else in it except a few bats.



The cavity below was in like manner rocky, and very irregular: the candles and torches burnt clear, so as to discover the whole extent thereof; nor was the air any thing offensive.

The three men that went down the first day staid below two hours and a half. The next day the captain went down with seven or eight men, who staid below for an hour, and observed all things.

The bottom of this hole, where the land-waters gather, is 59 yards down from the superficies of the earth, and by good calculation the same bottom is 20 yards above the highest rising of the Severn, and lies into the land about three miles distant from it.

The profile of the concave in Pen-park, before described: —*a* is the superficies of the earth; *b* the lead-ore pit; *c* the tunnel or passage down; *d* the long gallery; *e* the concave or cell; *f* the upper edge of the mud; *g* two small rocks that appear above the water; *h* the upper part of the water; *i* the bottom of the water.

The Anatomy of a Rattle-Snake. dissected by EDWARD TYSON.—

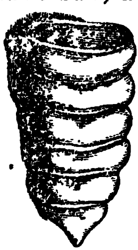
THE snake dissected was four feet five inches long; the girt of the body in the largest place, which was the middle, was six inches and a half; the girt about the neck three inches; near the rattle two inches; the head flat on the top, as is the viper, and by the protuberance of the maxillæ somewhat representing the head of a bearded arrow; at the extremity of it were the nostrils; between them and the eyes, but somewhat lower, were two other orifices, which I took for the ears, but afterwards found, they only led into a bone that had a pretty large cavity, but no perforation. Vipers have not these orifices in the head; and Charas says they hear by the nostrils; and that to them run not only the olfactory but auditory nerves also. The eye was round, about one fourth of an inch in diameter; in colour, the make of the pupil, and other respects, like a viper's, as indeed, except in the rattle, was the whole external shape of this animal. There was a large scale jetting over the eye, which seemed to serve as a palpebra for defending it from any thing falling on it; but I could not perceive it was capable of closing, although inwards it seemed to have a membrana nictitans, which removes any dust that might adhere to the eye.

The scales on the head were the smallest of any; those on the back larger, and so proportionably greater to the largest

part of the body; and so diminishing thence again to the setting on of the rattle; all in figure somewhat resembling parsnip seeds. Their colour various: the scales on the back had an edged rising in the middle, which was still less protuberant as they grew nearer the sides, where they were flat.

The belly seemed flat, covered with long scales of a yellowish colour, speckled black. From the neck to the anus we numbered 168; beyond the anus were two half scales; thence 19 whole scales of a black lead colour with yellowish edges; from thence to the rattle six orders or rows of smaller scales of the same colour.

To the last vertebra of the tail was fastened the rattle; in our subject there were but five, but some others seemed to be broken off. That next the tail was of a lead-colour, the others of a cineritious. It is well described by Dr. Grew, who says, "they are very hollow, thin, hard, and dry bones, and therefore very brittle, almost like glass, and very sonorous. They are all very nearly of the same bulk, and of the self-same figure, most



like the os sacrum of a man; for although the last of them only seems to have a rigid tail, or epiphysis adjoined to it, yet have every one of them the like: so that the tail of every uppermost bone runs within two of the bones below it: by which artifice they have not only a movable coherence, but also make a more multiplied sound, each bone hitting against two others at the same time.

The first figure exhibits a single rattle, which has three joints: the first and largest appears when conjoined with others; the two others serve for the fastening on the succeeding rattle, and are covered by them.

The second shows the five rattles as joined together.

On Animal Power. By J. A. Borelli.

The author first gives an exact description of a muscle, which within its tendinous or nervous membrane contains several small bundles of fibres, which constitute an hexagonal square, or triangular prism; the fibres themselves in each prism being parallel, and variously connected to each other; the microscopical appearance of a single fibre representing a cylinder, not hollow like a reed, but full of a spongy pith like elder. He gives an account of the several species of muscles,

from the position of their fibres, and asserts their proper action to be contraction. He confutes the common opinion, that nature with a very small force lifts up the greatest weights, the contrary being demonstrated, that the power exceeds the weight of the limbs that are lifted up by it 100 or 1000 times.

He gives us, likewise, an account of the wonderful structure of the back-bone, to the cartilages of which he attributes a greater force than to all the muscles that contract it, as is evident from this proposition: that if a porter carry on his back a weight of 120lb., the power nature exercises by the cartilages of the vertebræ, and the musculi extensores of the back, is equal to the force of 25,585lb.; that of the muscles alone he computes to be 6404lb ; and observes, that the retention of a joint stretched out is not from the tonical action of antagonist muscles.

Hence he goes on to deliver the various postures of an animal, which he does by assigning his centre of gravity in all his possible positions. As in a man stretched out at length, the centre is between the nates and pubês. That a man cannot well stand on one heel, or tip of a toe, because in these cases the line of direction falls without his basis, &c.

That though birds have two feet, yet they neither walk nor stand the same way as a man; which depends on the different structure of their joints. For, 1. they differ in the number of the bones. 2. In the form. 3. In the distribution and make of their muscles. 4. In the joints themselves.

He demonstrates the manner how a bird when sleeping sits firm on a twig, though the muscles are then inactive; namely, by a strong constriction of its claws, and, consequently, a firm comprehension of that twig, necessarily and mechanically resulting from the gravity of the bird, and the shortness of the tendons of those muscles that contract the claws.

That quadrupeds cannot stand in their natural prone position on one or two feet, because the centre of gravity and its line of propension cannot fall in either, or between both.

He shows the art of skating upon ice, as also how progression in quadrupeds is performed, and likewise leaping, in which the vis motiva is to the weight of the body as 2900 is to one. That in leaping according to a line inclined to the horizon, at oblique angles, the line described by the centre of gravity shall be a curve parabola, as being compounded of the straight uniform motion forward, and the accelerated descent of the heavy body. Next he gives an exact account

of flying, the main stress of which is in the largeness of the muscles that move the wings, the potentia of which exceeds the weight of the bird 10,000 times; with many more curious particulars about their several ways of flying.

He describes the action of swimming, and how fishes change their specified gravity on occasion, by the compression and dilatation of the air contained in their air-bladders, performed by the many and strong muscles about their bellies. He assigns the reason why man does not swim by instinct as well as other animals, to be chiefly on account of the gravity of the head so much exceeding the proportion of that of the rest of the body.

In the second part the author describes the mechanical mode, and assigns the immediate cause, by which the contraction of the muscles is performed.

Concluding that the muscles are contracted from the inflation of their fibres by adventitious bodies, as it were by wedges; and having refused an incorporeal natural faculty for the immediate mover, as also any aërial substance, and rejected the blood filling the pores of the muscles, together with the manner by which moistened ropes are contracted, he infers, that the ebullition, caused in the muscles by the concurrence of the blood and succus nerveus, is the immediate cause of the intumescence and contraction, which he confirms and illustrates by arguments and experiments.

He next gives an account of the internal motions of the fluids of the body, as of the circulation of the blood; describing the muscular structure of the heart, and showing how it differs from other muscles by the wonderful texture of its fibres.

He at last infers that the moving faculty of the heart exceeds the resistance of the whole blood in the arteries, and of the ligaments that hinder their dilatation, which is greater than the force of a weight of 180,000.

He ascribes respiration wholly to the muscles that enlarge the thorax, viz. the intercostals and the diaphragm, together with the weight and elasticity of the air. The manner, by drawing up the circumference of the ribs towards the throat, by directions that make acute angles with the plains of the ribs. The structure of the thorax in the tortoise, he observes, is remarkable, there being no divided ribs, but one continued bony arch, and no diaphragm: and instead of lungs, two long bladders, containing also the blood-vessels. These bags are not alternately filled and emptied, but constantly remain full of air, which is not renewed in them but partially, by the

external muscles that stick to the skin, which when inactive. make a hollow sinus, but contracted, a plane.

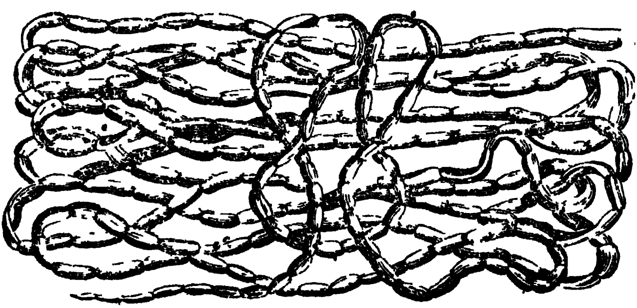
A Discourse read before the Royal Society, concerning the jointed Worm. By EDWARD TYSON

I SHALL begin with the jointed worm; and shall discriminate this from all other sorts of worms. And the first is, its being flat; hence called lumbricus latus, and by Hippocrates, ταινία, i. e. fascia, and in English, *the tape-worm.* This flatness of the body sufficiently distinguishes it from the others, which are usually bred in the body; which are either short and small, and then called ascarides, or longer, as the teretes. Nor is there any out of the body that I know of, that are thus flat.

In one I have by me 24 feet long, about five joints make an inch; whereas the latter joints here are above an inch long; but in some I have taken out of dogs, there were 30 or 40, sometimes above 60 annuli, which, towards the head, make up but the length of an inch; whereas towards the tail six or seven joints equalled that measure, and sometimes three; so that gradually the joints seem to increase, both in length and breadth, as they approach the tail.

As to the length of this worm, it is sometimes as long as all the bowels; not that it lies extended straight the length of the guts, as those might think, who fondly imagined it was nothing else but a mucous skin, or spolium of the same: but it lies convoluted in several places; so that it often vastly exceeds the whole length of the intestines themselves. Platerus observed one 40 feet long; and Pliny says, they are sometimes 300 feet or more. Thaddæus Dunus saw voided by a woman one piece of this worm five yards long; and another, above 20 yards long. Yet in neither could he observe either the head or the tail. But what Olaus Borrichius tells us is remarkable; that a patient of his, in a year's time, has voided 800 feet of this sort of worm, but in several pieces; and that 200 feet of it he kept by him; and that hitherto he has not met with the head. For the patient observed, that always in the voiding it, he perceived it break off; that he has not yet come to the end; and still goes on voiding the same. Which I could parallel with an instance of a person, once my patient, who has voided vast quantities of this worm, for several years together; but in several pieces, 2, 3, 4, 6, or more yards long; but all put together, would much exceed the length of that of Borrichius. Tulpius

says he showed, in the Anatomy Theatre, 40 yards of this worm; which was voided by one in two days' time. However, I question whether all those pieces which are voided by the same person may be always reputed parts of the same worm, or of different. Yet this is undeniable, and must be allowed, that this worm is amazingly long, which plainly appears even by those pieces we see of them; for, besides the instances already given, Simon Schultzius mentions one seven yards long, and another nine yards. Clusius tells us, that the Duke of Austria's cook voided pieces of this worm, 6, 12, and 15 yards long. Jacobus Oethæus measured one 18 yards long. Alexander Camerarius has seen them above 20 yards long. In the palace at Tiguri is kept the figure of one 18 feet long: and abundance of more instances I could give were it needful.



'But I shall describe that piece of one I have by me, voided by a young man about 20 years of age, on the use of an emulsion of the cold seeds, who plainly perceived it alive, and to move; and having put it in a wide mouthed-glass, it often endeavoured by raising its body to get out; but the cold water into which it was put afterwards soon killed it. I measured it and found it 24 feet, or eight yards long. In it I numbered 507 joints. Its colour was extreme white, being turgid with chyle; its body flat, about the thickness of half a crown, where thickest; and the joints towards the tail about one fourth of an inch broad; those towards the head about one fourth as broad as those towards the tail, and the joints were not one fourth of an inch long, whereas those at the tail were a full inch long, and something more; and from the head they seemed gradually to increase in length. The joints much of a wideness throughout; and the jetting edges of the former over the latter usually plain and even; unless where the contraction of the body had rendered them a little crimpled

The flats of both sides just alike; and without any spots, protuberances, or any thing remarkable, which might distinguish them, or be observed, only a smooth surface; but about the middle of the edges of each joint I observed a protuberating orifice, which would easily enough admit a hog's bristle, and was open, and apparent to the naked eye. These orifices were placed for the most part alternately, in one joint on the right side, in the following on the left. But sometimes I have observed them in two, more seldom in three succeeding joints of the same side; but never in one joint more than once. These orifices I take at present for so many mouths. But since I have here mentioned of what length they have been observed in man, I shall also add how long those were I have seen in dogs. For though they are to be met with only in the animal kingdom, yet in abundance of the subjects of this, and those too of different species, they are very frequent; in fishes, as in the pike, whitings, bleaks, crabs, herrings, &c. and upon this score sometimes they prove a great damage to the merchants, as Platerus observes, they being forced to throw them away. In bleaks in the summer-time, if you open those that leap and tumble on the water, from the torment they feel within, you almost constantly meet with this worm, which is a thing well known to the watermen. In oxen often they are observed likewise, not so much in calves; but in dogs very frequently; which Platerus makes to be another sort of the tænia, and calls it ligula. Simon Schultzius mentions a lap-dog that in a short time voided nine yards of this worm in several pieces.

I have oftentimes here seen them myself, but shall mention those only I found in dissection; as I met with the first time two. There was indeed another piece, which I take only as broken off from one of the former, because here both extremes were pretty large, and the joints throughout proportionably long. But in the two others the disproportion was very remarkable; for besides observing here their heads thick beset with hairs or small spikes, which I shall afterwards describe, I took notice that this extreme, if extended, was very slender; and when a little contracted, the joints so very small, that they were scarcely discernible by the naked eye; but where I could better distinguish them, between 30 and 40 made the length of an inch; but towards the other extreme or tail, in one four, in the other six or seven joints made an inch in length; one of these worms was scarcely a foot long; the other not a foot and a half.

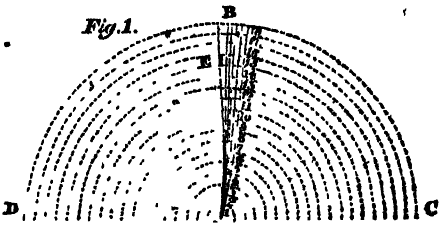
In another dog I since dissected, I found another worm,

with just the same head, but about five feet long; towards the head in this 60 joints scarcely made an inch, but at the tail about three equalled that space; and the joints here were about a quarter of an inch broad; and in the sides of the joints in this, I plainly perceived those orifices I at present call the mouths.

Letter from Mr. ANTHONY LEUWENHOEK, *of Delft, concerning the Appearances of several Woods, and their Vessels.*

I SEND you here some observations on wood. B C D (fig. 1.) is a part of the circumference of an oak or ash tree, &c. being of 18 years' growth, and therefore having 18 rings, one for each year; that which is made the last year being always the greatest, though not always proportionably great, but according as the year is more or less fruitful.

Fig. 1.



The pieces described in the following figures are such as E in the 15th ring, and sometimes not so large; yet from such a part I doubt not but the constitution of the whole tree may sufficiently be understood.

When a tree is sawed across, and afterwards planed very smooth, we see lines, as it were, drawn from the centre A, and reaching to the circumference B; these are vessels which carry the sap to the bark; as by the adjoined figures will appear.

In fig. 2. A B C D shows a piece of oak, which observed in a microscope was thus drawn from a piece of wood as large as

Fig. 2.

II. F F are the separations of the growth of one year. For when the growth stops, the wood becomes firm and thick; and is supplied with many small vessels, such as are hardly to be distinguished, and therefore appear as brown rays or streaks. Between the said F F, F F, is comprehended that thickness of wood which has been added to the circumference of a tree by a year's growth. The wood has five sorts of vessels, viz. Three sorts going upwards, and two lying horizontally. E E E denote large ascending vessels made every year in the wood in the spring, when it begins to grow.

All these ascending vessels in the aforesaid piece of wood, which is about $\frac{1}{25}$ of a square inch, are I guess about 20,000. Hence in an oak-tree of four feet diameter are 3200 millions of ascending vessels, and in one of one foot there are 200 millions of vessels. If we suppose 10 of these great and small vessels in a day to carry up one drop of water, and that 100 of these drops make one cubic inch, there will be 200,000 cubic inches.

These forementioned uprising vessels empty constantly their sap into an incredible number of vessels, which lie horizontally in the body of the tree, to cause a continual growth in thickness. Fig. 2., G G G, are a sort of vessels which run horizontal, beginning from the pith of the tree, but afterwards in great numbers taking their rise from the ascending vessels.

Fig. 3.

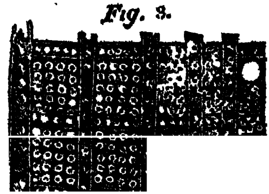
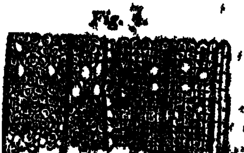


Fig. 3. is a little piece of black Mauritius ebony wood, and this little piece of wood, wherein are shown about 1100 rising vessels, is no larger than an ordinary grain of sand.

Fig. 4. is a piece of palm-wood; and though I examined a great deal of it, I could find little difference in the several parts, and therefore I have here contented myself with describing a smaller portion. It consists of two sorts of ascending ... viz. great vessels, and smaller ones lying among the larger.

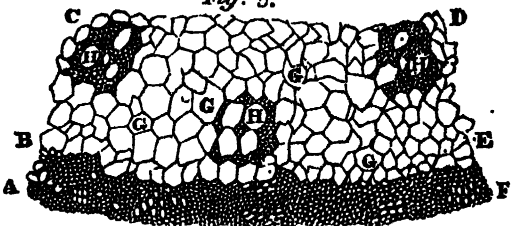
Fig. 4.



A B C D E F (fig. 5.) is a piece of stra[w cut] across, in which the part of the circumference A F [may] be discerned how great it is. A B E F is the rind of th[e] straw, which to outward appearance is smooth

and shining, though for the most part it is made of extremely small vessels, and of some greater; which I have represented

Fig. 5.



as near as possible. G G G G are the vessels of which the innermost parts of the straw are made; these vessels are four, five, and six sided. according as they come to fit themselves. H H H are other vessels which run in between the forementioned ones, and are beset round with small vessels. In these vessels I have seen the sap sink down suddenly at the time of the growing of the straw, when at the same time I saw the sap rise up in the vessels G G, which sap was made mostly of globules; and when the globules came to pass the valves, where the vessels were narrowest, these globules then changed into the form of cones. till they obtained a larger room, and then they [illegible] their former globular shape.

A Conjecture on under Currents at the Straits' Mouth and other Places. By THOMAS SMITH, *D.D*

AT the Straits, there is a vast draught of water poured continually out of the Atlantic into the Mediterranean; the mouth or entrance of which between Cape Spartel or Sprat, as the seamen call it, and Cape Trafalgar, may be near seven leagues wide, the current setting strong into it, and not losing its force till it runs as far as Malaga, which is about 20 leagues within the Straits. By the benefit of this current, though the wind be contrary, if it does not overblow, ships easily turn into the Gut, as they term the narrow passage, which is about 20 miles in length. At the end of which are two towns, Gibraltar on the coast of Spain, which gives denomination to the strait, and Ceuta on the Barbary coast; at which places Hercules is supposed to have set up his pillars. What becomes of this great quantity of water poured in this way; and of that which runs from the Euxine into the Bosphorus and Propontis, and carried at last through the Hellespont into the Ægean or Archipelago, is a curious speculation, and

has exercised the ingenuity of philosophers and navigators. For there is no sensible rising of the water all along the Barbary coast, even down to Alexandria, the land beyond Tripoli, and that of Egypt lying very low, and easily to be overflowed. They observe, indeed, that the water rises three feet or three feet and a half in the Gulf of Venice, and as much, or very near as much, all along the river of Genoa, as far as the river Arnô; but this rather adds to the wonder.

I here omit to speak at large of the several hypotheses which have been invented to solve this difficulty; such as subterraneous vents, cavities, and indraughts, exhalations by the sun-beams, the running out of the water on the African side, as if there were a kind of circular motion of the water. My conjecture is, that there is an under-current, by which as great a quantity of water is carried out as comes flowing in. To confirm which, besides what might be said about the difference of tides in the offing, and at the shore in the Downs, which necessarily supposes an under-current, I shall present you with an instance of the like nature in the Baltic sound, as I received it from an able seaman, who was at the making of the trial. He told me, that being there in one of the king's frigates, they went with their pinnace into the mid stream, and were carried violently by the current; that soon after they sunk a bucket with a large cannon ball, to a certain depth of water, which gave check to the boat's motion, and sinking it still lower and lower, the boat was driven ahead to windward against the upper current: the current aloft, as he added, not being four or five fathom deep, and that the lower the bucket was let fall, they found the under current the stronger.

Of the Pores in the Skin of the Hands and Feet. By NEH. GREW, M.D

THE pores in the hands and feet are very remarkable; both in respect of their position and their amplitude. For if any one will but take the pains, with an indifferent glass, to survey the palm of his hand very well washed with a ball, he may perceive innumerable little ridges, of equal size and distance, and every where running parallel to each other. And especially on the ends and first joints of the fingers and thumb, on the top of the ball, and near the root of the thumb a little above the wrist. In all which places, they are very regularly disposed into spherical triangles and ellipses. On these ridges stand the pores, all in even rows, and of such a

magnitude, as to be visible to a good eye, without a glass. But being viewed with one, every pore looks like a little fountain, and the sweat may be seen to stand therein, as clear as rock-water, and often as it is wiped off, to spring up within them again.

What nature intends in the position of these ridges, is, that they may the better suit with the use and motion of the hand: those of the lower side of every triangle, to the bending in or clutching of the fingers; and those of the other two sides, and of the ellipses, to the pressure of the hand or fingers' ends against any body, requiring them to yield to the right and left. On these ridges the pores are very providently placed, and not in the furrows which lie between them; that so their structure might be the stronger, and less liable to be depraved by compression; whereby only the furrows are dilated or contracted, the ridges constantly maintaining themselves, and so the pores unaltered. For the same reason, the pores are also very large, that they may still be the better preserved, though the skin be ever so much compressed and condensed, by the constant use and labour of the hand. So likewise those of the feet, notwithstanding the compression of the skin by the weight of the whole body.

Letter from Mr. Anthony Leuwenhoek, about Animals in the Scurf of the Teeth, the Substance called Worms in the Nose, and the Cuticula consisting of Scales.

Though my teeth are kept usually very clean, yet when I view them in a magnifying glass, I find growing between them a little white matter, as thick as wetted flour: in this substance, though I could not perceive any motion, I judged there might probably be living creatures. I therefore took some of this flour, and mixed it either with pure rain-water wherein were no animals, or else with some of my spittle, having no animals nor air-bubbles to cause a motion in it; and then to my great surprize perceived that the aforesaid matter contained very many small living animals, which moved themselves very strangely. The largest sort were not numerous, but their motion strong and nimble, darting themselves through the water or spittle, as a jack or pike does through the water. The second sort spun about like a top, and were more in number than the first. In the third sort I could not well distinguish the figure, for sometimes it seemed to be an oval, and other times a circle: these were exceedingly small, and so swift, that I can compare them to nothing better than

a swarm of flies or gnats, flying and turning among each other in a small space. Of this sort I believe there might be many thousands in a quantity of water no larger than a sand, though the flour were but the ninth part of the water or spittle containing it. Besides these animals, there were a great quantity of streaks or threads of different lengths, but of like thickness, lying confusedly together, some bent, and others straight. These had no motion or life in them.

I observed the spittle of two several women, whose teeth were kept clean, and there were no animals in the spittle; but the meal between the teeth, being mixed with water, as before, I found the animals above described, as also the long particles. The spittle of a child of eight years old had no living creatures in it, but the meal between the teeth had a great many of the animals above described, as also the streaks. The spittle of an old man that had lived soberly had no animals in it; but the substance upon and between his teeth had a great many living creatures swimming nimbler than I had hitherto seen. The largest sort were numerous, and as they moved bent themselves. The other sorts of animals were in great numbers, insomuch that though the meal were little, yet the water it was mixed with seemed to be all alive; there were also the long threads above mentioned. The spittle of another old man, a top[illegible] was like the former, but the animals in the scurf on the teeth were not all killed by his continual taking brandy, wine, and tobacco; for I found a few living animals of the third sort, and in the scurf between the teeth I found many more small animals of the two smaller sorts.

I took in my mouth some very strong wine-vinegar; then closing my teeth, I gargled and rinsed them very well with the vinegar; and afterwards I washed them very well with fair water; but there were innumerable quantities of animals still remaining in the scurf on the teeth, but most in that between the teeth, and very few animals of the first sort. I took a very little wine-vinegar, and mixed it with the water in which the scurf was dissolved; upon which the animals died presently. From hence I conclude, that the vinegar with which I washed my teeth killed only those animals which were on the outside of the scurf, but did not pass through the whole substance of it. . . . .

The number of these animals in the scurf of a man's teeth are so many, that I believe they exceed the number of men in a kingdom. For on the examination of a small parcel of

it, no thicker than a horse-hair, I found so many living animals in it, that I guess there might have been 1000 in a quantity of matter no larger than the $\frac{1}{100}$ part of a sand.

A certain man being said to have worms taken out of his face, I took a quantity of these imagined worms, which I laid upon a clean glass, that I might view them at my leisure. I found them not to differ considerably; unless it were that some of the hairs in these supposed worms were so tender, that they broke in two on the least touch. Other worms seemed to be a bundle of hairs, but when I went to separate them, it was just as if I had touched a soft fat body. I squeezed some black specks out of the thick of my own nose, which I saw to be bundles of hairs, I then took out hairs from one of them to the number of 36. I took the worms out of the noses of two other persons, and I found the number of hairs in a bundle to be from 3, 4, 5, 6, and 9 to 25, and 30. When the worms lay deepest in the nose, they seldom contained any hairs, unless the person they came from were very black, and then the hairs were more easily perceivable. In the pressing out of worms, I could tell whether there were hairs in them or not; for if the substance came out straight, then there were always hairs; but if bended none.

In the year 1674, I asserted that the cuticula, or upper skin of a body, consists of round particles or scales. I then saw by a common microscope the parts of the scales appearing to the eye as if they were round, lying close in order, and so small that a sand would cover 200 or 250 of them. But examining them since by a glass which magnifies more, I am satisfied that they are not made out of the grosser part of the moisture or substance which is evaporated out of the body, as I formerly thought, but are mere scales. such as grow on the outward skin of a fish, and called fish-scales. These scales lie on our body just as they do upon fishes, the most part of them are five-sided, and are very thin, for I judge their breadth is about 25 times more than their thickness. They lie three deep on the body, every part being covered with three scales successively, though not above $\frac{1}{3}$ part of a scale discovers itself to the eye, the other $\frac{2}{3}$ parts being hid by the other scales.

The scales of fishes also appear but in part to the eye; but it is very remarkable, that though fishes never change their scales, yet men do often; particularly I instance in myself at this time, being the 1st of September, that the scales came off me not one by one, but 1000 in a cluster. When I pluck

off a scale from my body which sticks fast, and perhaps is but newly grown; there comes blood after it, or at least there remains a red spot.

It is easy to conceive how a louse, flea, or other insect, may thrust his sting or snout into the skin; for they need not do it through the scales, but between the plates or mails. From hence also may be perceived, that there are no pores in the cuticula, for the conveying out of sweat, because that may ooze out from between the scales, though they stick never so close together, without supposing that there are channels made for its passage. Let us only reckon how many vacuities a scale has, whereby it is nourished so as to grow, and that in the space of ¼ part of a scale there may be 100 such vacuities, through which the humours of the body may pass, and that 200 such parts of a scale may be covered with a sand. It will follow, then, that the body may exhale out of 20,000 places in a quantity no larger than what a sand will cover.

Of the Bogs in Ireland. By Mr. WILLIAM KING.

As to the origin of bogs, it is to be observed, that there are few places in our northern world but have been noted for them, as well as Ireland: every barbarous ill-inhabited country has them. I take the loca palustria, or paludes, to be the very same we call bogs: the ancient Gauls, Germans, and Britons, retiring, when beaten, to the paludes, is just what we have experienced in the Irish; and we shall find those places in Italy that were barbarous, such as Liguria, were infested with them, so that the true cause of them seems to be want of industry. To show this, we are to consider, that Ireland abounds in springs; that these springs are mostly dry in the summer, and the grass and weeds grow thick about those places. In the winter they swell and run, and soften and loosen all the earth about them. Now that swerd or surface of the earth, which consists of the roots of grass, being lifted up and made fuzzy or spongy by the water in the winter, is dried in the spring, and does not fall together, but wither in a tuft, and new grass springs through it, which the next winter is again lifted up; and thus the spring is still more and more stopped, and the swerd grows thicker and thicker, till at first it makes what is called a quaking bog, and as it rises and becomes drier, and the grass roots and other vegetables become more putrid, together with the mud and slime of the water, it acquires a

blackness, and becomes what is called a turf-bog. I believe when the vegetables rot, the saline particles are generally washed away with the water, in which they are dissolved; but the oily or sulphureous remain and float on the water; and this is that which gives turf its inflammability. To make this appear, it is to be observed, that in Ireland the highest mountains are covered with bogs as well as the plains, because the mountains abound much in springs. Now these being uninhabited, and no care being taken to clear the springs, whole mountains are thus over-run with bogs.

It is to be observed, also, that Ireland abounds in moss more than probably any other country, insomuch that it is very apt to spoil fruit-trees and quicksets. This moss is of divers kinds, and that which grows in bogs is remarkable; for the light spongy turf is nothing but a congeries of the threads of this moss, before it be sufficiently rotten; and then the turf looks white, and is light. It is seen in such quantities and is so tough, that the turf-spades cannot cut it. — In the north of Ireland they call it old-wives' tow, as it is not much unlike flax: the turf-holes in time grow up with it again, as well as all the little gutters in the bogs; and to it the red or turf bog is probably owing; and from it even the hardened turf, when broken, is stringy, though there plainly appear in it parts of other vegetables; and it is probable that the seed of this bog-moss, when it falls on dry and parched ground, produces heath.

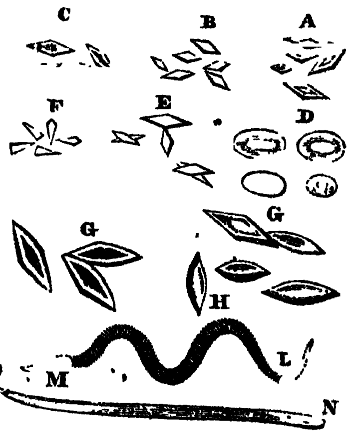
The inconveniences of these bogs are very great; a considerable part of the kingdom being rendered useless by them: they keep people at a distance from each other, and consequently interrupt them in their affairs. Generally, the land which should be our meadows, and the finest plains, are covered with bogs; this is observed over all Connaught, but more especially in Longford and also in Westmeath, and in the north of Ireland. These bogs greatly obstruct the passing from place to place; and on this account the roads are very crooked, or they are made at vast expence through bogs. The bogs are a great destruction to cattle, the chief commodity of Ireland; for in the spring, when they are weak and hungry, the edges of the bogs have commonly grass, and the cattle venturing in to get it, fall into pits of sloughs, and are either drowned or hurt in the pulling out: the number of cattle lost this way is incredible.

Turf-bogs preserve things a long time: a corpse will lie entire in one for several years; also trees are found sound and entire in them, and even birch and alder, that are very

subject to rot; such trees burn very well, and serve for torches in the night.

Concerning the Salts of Vinegar, &c. By M. Anthony *Leuwenhoek.*

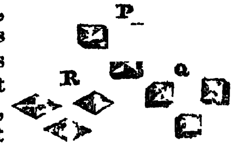
Having found my yearly provision of vinegar, which had been about three months in the cellar, to be more sour than ordinary, I left it open to the air during some hours, at which time I observed a great many particles, which I call the salt of the vinegar, as fig. A, tapering towards each end; and having in the middle a long brownish figure: others of the same extent, as fig. B, being as clear as crystal; and these were the most numerous: others being long and brownish, having in the middle of them a bright clear substance, as fig. C. In another place were some few oval figures, within which were contained some lesser ovals, as fig. D. Under the aforesaid figures, A, B, C, I thought I saw many that had a hollowness within them, like that of a boat; sometimes one of the figures appeared, the one half brown, and the other part clear; sometimes one of the figures lay across another, as at E. Sometimes there were figures which seemed to have been cut in two, each of them representing but one half of A, B, or C, as F. Many of these figures were so small, as scarcely to be seen, but so numerous that I judged them to be many thousands in one small drop of vinegar. These particles I take to be the sharp pungent matter, which causes the sense in the tongue, which we term sour.



Having put into a glass about two inches wide a little vinegar, it was suffered to stand on my table for eight weeks. In this time I found swimming on the surface of the vinegar a full grown live eel, L M and N O, of which there were many more in the vinegar.

I took several new glasses with vinegar, and put in them some crabs' eyes, split into small pieces, lest the grit that

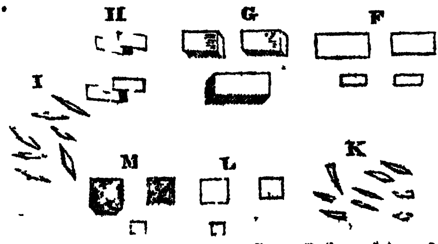
comes from them, when pounded, should hinder my sight: I found that the long sharp figures which might be likened to a weaver's shuttle, were now changed into figures, whose basis was oblong, rising up pyramidally, like a pointed diamond, as P. Others had their basis square, as Q. Others an irregular quadrilateral, as R. But these last two figures, I supposed, were accidental, for want of sufficient matter to complete, and perfect them on all sides. The number of particles was so great, that in a gross computation I judged them to be 6000 in a drop about the size of two barley-corns.



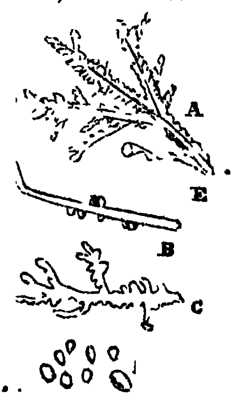
I took some vinegar out of a glass, that had crabs' eyes in it, at a time before all the air-bubbles were ascended: but even then the basis of the salt particles was four-square, and not as in common vinegar. The liquor had quite lost its acidity. I took also white chalk, beaten to pieces, and put it in vinegar, where it caused as great a commotion and rising of air-bubbles as the crabs' eyes had done: it produced also the same figures of the salt, and the same insipidness.

Abstract of a Letter from Mr Leeuwenhoek to the R. S., dated Jan. 23. 1684-5, concerning the various Figures of the Salts contained in several Substances.

I TOOK some of the salt of Carduus Benedictus, such as is commonly sold in the apothecaries' shops: it was rather moist, and its parts seemed to be so huddled up together, that they could not be distinguished from one another: I closed it up in a glass, to prevent the evaporation; and when it had stood stopped for some days, many of the particles were run together, on the side of the glass, forming some flat longish figures, of different magnitudes, the largest in length about the diameter of a hair of my beard, as fig. F. In another place, these salts lay so, that I could easily discern their thickness, as fig. G. In another place, the thin flat salts lay over one another, as fig. H. I put this salt



in water to dissolve it, and took of it about as much as two barley-corns, spreading it thin before me: and when it was in motion, I not only observed the above-mentioned figures, and shootings of the salt, but found several new figures which were thin and long, and sharp towards both ends, as fig. I. Others that lay near them were broader, but not so long, and their ends not so sharp, as fig. K. I saw also some perfect four-square figures, as fig. L; but they had no thickness that I could discover. Also there were some quadrilateral pyramidal figures, like those of common salt, as fig. M. These observations must be made before the water is evaporated, for when the water is almost gone, such a multitude of particles appear, and run together, that they cause a confusion. On a further examination, of a more genuine sort, I perceived very plainly a number of figures tapering towards both ends, as above mentioned in fig. I. After about a day's time, I saw several flat figures, as F and H. But having dissolved the salt in rain water, and viewed it as it lay thin upon my plate, I found all the above-mentioned figures; but those of K, L, and M, exceeded in number all the rest; insomuch, that I conceived I saw more in a quantity of water equal to the weight of a grain, than there are stars to be seen in the heavens by the naked eye.



Sal Ammoniac.—The figure of this salt dissolved in water generally appeared like the boughs of a tree, beset with irregular leaves, one larger than another, as is represented A E. In another place lay five or six branches like A, seeming to proceed from a common centre, as E. I saw also salt particles like B and C; and where there were no branches, the scattered salts looked like so many flints, differing from each other in size, but being never perfectly round, as fig. D.

A Discourse concerning Gravity and its Properties; and on the Laws of the Descent of heavy Bodies. By E. Halley

Nature, amidst the great variety of problems wherewith she exercises the wits of philosophical men, scarcely affords any one wherein the effect is more visible, and the cause

more concealed, than in those of the phænomena of gravity or weight. Before we can go alone, we must learn to defend ourselves from the violence of its impulse, by not trusting the centre of gravity of our bodies beyond our reach; and yet the acutest philosophers, and the subtilest enquirers into the original of this motion, have been so far from satisfying their readers, that they themselves seem little to have understood the consequences of their own hypotheses.

The notion of Descartes seems to be quite incomprehensible; he would have the particles of his celestial matter, by being reflected from the surface of the earth, and so ascending from it, to drive down into their places those terrestrial bodies they find above them: this is as near as I can gather the scope of the 20, 21, 22, and 23 sections of the last book of his Principia Philosophiæ; yet neither he, nor any of his followers, can show how a body suspended in free ether shall be carried downwards by a continual impulse tending upwards.

Vossius and others assert the cause of the descent of heavy bodies to be the diurnal rotation of the earth upon its axis; not considering that, according to the doctrine of motion, all bodies moved in a circle recede from the centre of their motion; by which an effect contrary to gravity would follow, and all loose bodies would be thrown into the air in a tangent to the parallel of latitude without the intervention of some other principle to keep them fast, such as that of gravity. Besides, the effect of this principle is found throughout the whole surface of the globe nearly equal; and certain experiments seem to argue it rather less near the equator than towards the poles; which could not be the case, if the diurnal rotation of the earth on its axis were the cause of gravity; for where the motion is swiftest, there the effect would be most considerable.

Others assign the pressure of the atmosphere, as the cause of this tendency towards the centre of the earth; but unhappily they have mistaken the effect for the cause, it being plain from undoubted principles, that the atmosphere has no other pressure but what it derives from its gravity; and that the weight of the upper parts of the air, pressing on the lower, do so far bend the springs of that elastic body, as to give it a force equal to the weight that compressed it, having of itself no force at all: and supposing it had, it will be very hard to explain the modus, how that pressure should occasion the descent of a body circumscribed by it, and pressed equally above and below, without some other force to draw or push it downwards. But to demonstrate the con-

trary of this opinion, an experiment was long since shown before the Royal Society, by which it appeared, that the atmosphere was so far from being the cause of gravity, that its effects are much more vigorous where the pressure of the atmosphere is removed; for a long glass receiver, having a light down-feather included, being evacuated of air, the feather, which in the air would hardly sink, did in vacuo descend with nearly the same velocity as a stone.

Some think to illustrate this descent of heavy bodies, by comparing it with the virtue of the loadstone. But, setting aside the difference in the manner of their attractions, the loadstone attracting only in and about its poles, but the earth almost equally in all parts of its surface, this comparison avails no more than to explain unknown things by another equally so.

Others assign as the cause, a certain sympathetical attraction between the earth and its parts; whereby they have, as it were, a desire to be united. But this is so far from explaining the modus, that it is little more than telling us in other terms, that heavy bodies descend, because they descend.

But though the efficient cause of gravity be so obscure, yet its final cause is clear enough; for it is by this single principle, that the earth and all the celestial bodies are kept from dissolution: the least of their particles not being suffered to recede far from their surfaces, without being immediately brought down again by virtue of this natural tendency; which, for their preservation, the infinite wisdom of their Creator has ordained to be towards each of their centres; nor can the globes of the sun and planets be otherwise destroyed, than by depriving them of this power of keeping their parts united.

The affections or properties of gravity, and its manner of acting on falling bodies, have been in a great measure discovered, and most of them made out by mathematical demonstration, by the accurate diligence of Galileo, Torricelli, Huygens, and others, and now lately by our worthy countryman Mr. Isaac Newton, who has an incomparable Treatise on Motion almost ready for the press. Of these properties, the first is, that by this principle of gravitation all bodies descend towards a point, which either is, or else is very near to the centre of magnitude of the earth and sea, about which the sea forms itself exactly into a spherical surface, and the prominences of the land, considering the bulk of the whole, differ but insensibly from it. 2. This point, or centre of gravitation, is fixed within the earth, or at least has been so,

ever since we have any authentic history: for a consequence of its change, though never so little, would be the overflowing of the low lands on that side of the globe towards which it approached, and the leaving new islands bare on the opposite side, from which it receded. 3. That in all parts of the surface of the earth, or rather in all points equidistant from its centre, the force of gravity is nearly equal; so that the length of the pendulum, vibrating seconds of time, is found in all parts of the world to be nearly the same. 4. That gravity equally affects all bodies, without regard either to their matter, bulk, or figure; so that the resistance of the medium being removed, the most compact and the loosest, the greatest and smallest bodies, would descend the same spaces in equal times: the truth of which appears from the experiment before cited. In these last two particulars is shown the great difference between gravity and magnetism, the one affecting iron only, and that towards its poles, the other all bodies alike in every part. From hence it will follow, as a corollary, that there is no such thing as positive levity; those things that appear light, being only comparatively so; and whereas several things rise and float in fluids, it is because, bulk for bulk, they are not so heavy as those fluids; nor is there any reason why cork, for instance, should be said to be light because it swims on water, any more than iron because it swims on mercury. 5. That this power increases as you descend to, and decreases as we ascend from, the centre, and that in the proportion of the squares of the distances from it reciprocally, so as at a double distance to have but a quarter of the force; a principle on which Mr. Newton has made out all the phænomena of the celestial motions, in so easy and natural a manner, that its truth is past dispute.

Besides, it is highly rational, that the attractive or gravitating power should exert itself more vigorously in a small sphere, and weaker in a greater, in proportion as it is contracted or expanded; and if so, seeing that the surfaces of spheres are as the squares of their radii, this power at several distances will be as the squares of those distances reciprocally: and then its whole action on each spherical surface, be it great or small, will be always equal. And this is evidently the rule of gravitation towards the centres of the Sun, Jupiter, Saturn, and the Earth; and thence is reasonably inferred, to be the general principle observed by nature in all the other celestial bodies.

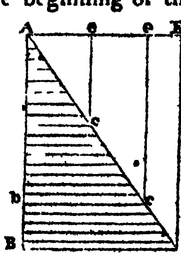
These are the principal affections of gravity, from which the rules for the fall of bodies, and the motion of projects, are mathematically deducible. Mr. Isaac Newton has shown

how to define the spaces of the descent of a body, let fall from any given height, down to the centre, supposing the gravitation to increase, as in the fifth property; but considering the smallness of height, to which any projectile can be made to ascend, and over how small an arch of the globe it can be thrown by any of our engines, we may well enough suppose the gravity to be equal throughout: and the descents of projectiles to be in parallel lines, which in reality are towards the centre, the difference being so small, as by no means to be discovered in practice.

Propositions concerning the Descent of heavy Bodies, and the Motion of Projects.

Prop. I. The velocities of falling bodies are proportional to the times, from the beginning of their falls. For the action of gravity being continual, in every space of time the falling body receives a new impulse, equal to what it had before, in the same space of time, received from the same power; for instance, in the first second of time, the falling body has acquired a velocity, which in that time would carry it to a certain distance, suppose 32 feet, and if there were no new force, it would descend at that rate with an equable motion; but in the next second of time, the same power of gravity continually acting on it superadds a new velocity equal to the former; so that at the end of two seconds, the velocity is double to what it was at the end of the first: and after the same manner may it be proved to be triple at the end of the third second, and so on. Therefore the velocities of falling bodies are proportional to the times of their falls. Q. E. D.

Prop. II. The spaces described by the fall of a body are as the squares of the times, from the beginning of the fall. Let A B represent the time of the fall of a body; B C, perpendicular to A B, the velocity acquired at the end of the fall; and draw the line A C; then divide the line A B, representing the time, into as many equal parts as you please, as b, b, b, b, &c. and through these points draw the lines bc, bc, bc, bc, &c. parallel to B C. It is manifest that the several lines, bc, represent the several velocities of the falling body, in such parts of the time as Ab is of A B, by the former proposition. It is likewise evident, that the area A B C is the sum of all the lines bc; so that the area A B C represents the sum of all the velocities, between none and B C, supposed in-



finitely many; which sum is the space descended in the time represented by A B. And, by the same reason, the areas A b c will represent the spaces descended in the times A b; so then the spaces descended in the times A B, A b, are as the areas of the triangles A B C, A b c, which by the 20th of the sixth of Euclid, are as the squares of their homologous sides A, B, A b that is, of the times. Therefore the descents of falling bodies are as the squares of the times of their fall. Q. E. D.

Prop. III. The velocity, which a falling body acquires in any space of time is double to that with which it would have moved the space descended by an equable motion, in the same time. For, draw the line E C parallel to A B, and A E parallel to B C, in the same fig. 1., and complete the parallelogram, A B C E: it is evident that its area may represent the space a body moved equably with the velocity B C would describe in the time A B; and the triangle A B C represents the space described by the fall of a body, in the same time A B, by the second proposition. Now the triangle A B C is half the parallelogram A B C E, and consequently the space described by the fall is half what would have been described by an equable motion with the velocity B C, in the same time: therefore the velocity B C, at the end of the fall, is double to that velocity, which in the time A B would have described the space fallen, represented by the triangle A B C, with an equable motion. Q. E. D.

Prop. IV. All bodies on or near the surface of the earth, in their fall, descend in such a manner, as at the end of the first second of time, to have described 16 feet and one inch, London measure, and acquired the velocity of 32 feet two inches in a second. The length of the pendulum, vibrating seconds, being found 39½ inches, the descent in a second will be found by the aforesaid analogy to be 16 feet one inch; and by the third prop. the velocity will be double thereto; and thus nearly it has been found by several experiments, which, by reason of the swiftness of the fall, cannot so exactly determine its quantity.'

From these four propositions, all questions concerning the perpendicular fall of bodies are easily solved; and either the time, height, or velocity being assigned, the other two may be readily found. From them, likewise, is the doctrine of projectiles deducible, assuming the two following axioms; viz. That a body, put in motion, will move on continually in a right line with an equable motion, unless some other force or impediment intervene, by which it is accelerated, or retarded, or deflected. 2dly, That a body being agitated by

two motions at a time, does by their compounded forces pass through the same points as it would do, if the two motions were divided and acted successively.

Account of the Trade Winds and Monsoons, observable in the Seas between and near the Tropics. By E. Halley.*

The whole ocean may most properly be divided into three parts; viz. 1. The Atlantic and Ethiopic Sea. 2. The Indian Ocean. 3. The great South Sea, or the Pacific Ocean. And though these seas do all communicate by the south, yet, as to our present purpose of the trade winds, they are sufficiently separated by the interposition of great tracts of land.

I. In the Atlantic and Ethiopic Seas, between the tropics, there is a general easterly wind, all the year long, without any considerable variation, excepting that it is subject to be deflected some few points of the compass towards the north or south, according to the position of the place.

II. In the Indian Ocean the winds are partly general, as in the Ethiopic Ocean, and partly periodical, that is, half the year they blow one way, and the other half nearly on the opposite points, and these points and times of shifting are different in different parts of this ocean: the limits of each tract of sea subject to the same change or monsoon are certainly very hard to determine; yet the following particulars may be relied on: —

1. That between the latitudes of 10° and 30° south, as between Madagascar and New Holland, the general trade wind about the south-east by east, is found to blow all the year long, after the same manner as in the same latitudes of the Ethiopic Ocean.

2. That the aforesaid south-east winds extend to within 2° of the equator, during the months of June, July, August, &c. to November, at which time, between the south latitudes of 3° and 10°, being near the meridian of the north end of Madagascar, and between 2° and 12° south latitude, being near Sumatra and Java, the contrary winds from the north-west, or between the north and west, set in and blow for half the year, viz. from the beginning of December till May; and this monsoon is observed as far as the Molucca isles.

3. That to the northward of 3° south latitude, over the whole Arabian or Indian Sea, and Gulf of Bengal from Sumatra to the coast of Africa, there is another monsoon, blowing from October to April, on the north-east points; but in the

other half year, from April to October, on the opposite points of S. W. and W. S. W., and that with rather more force than the other, accompanied with dark rainy weather; whereas the north-east blows clear. It is likewise to be noted that the winds are not so constant, either in strength or direction, in the Gulf of Bengal, as they are in the Indian Sea, where a certain steady gale scarcely ever fails. It is also remarkable, that the south-west winds in these seas are generally more southerly on the African side, and more westerly on the Indian.

4. There is a tract of sea to the southward of the equator subject to the same changes of the winds, viz. near the African coast, between it and the island of Madagascar, and from thence northward, as far as the line; wherein from April to October there is found a constant fresh S.S W. wind, which, as you go more northerly, becomes still more and more westerly, so as to fall in with the W.S.W. winds mentioned before, in those months of the year to be certain to the northward of the equator.

5. That to the eastward of Sumatra and Malacca, to the northward of the line, and along the coast of Camboia and China, the monsoons blow north and south, that is, the north-east winds are much northerly, and the south-west much southerly. This constitution reaches to the eastward of the Philippine isles, and as far north as Japan. The northern monsoon setting-in in these seas in October or November, and the southern in May, blowing all the summer months Here it is to be noted, that the points of the compass from whence the wind comes in these parts of the world are not so fixed as in those lately described, for the southerly will frequently pass a point or two to the eastward of the south, and the northerly as much to the westward of the north; which seems occasioned by the great quantity of land interspersed in these seas.

6. That in the same meridians, but to the southward of the equator, being that tract lying between Sumatra and Java to the west, and New Guinea to the east, the same northerly and southerly monsoons are observed; but with this difference, that the inclination of the northerly is always towards the north-west, and of the southerly towards the south-east. But the points from which the winds blow are not more constant here than in the former, viz. variable five or six points. Besides, the times of the change of these winds are not the same as in the Chinese seas, but about a month or six weeks later.

7. That these contrary winds do not shift all at once; but

in some places the time of the change is attended with calms, in others with variable winds; and it is particularly remarkable, that the end of the westerly monsoon on the coast of Coromandel, and the last two months of the southerly monsoon in the seas of China, are very subject to be tempestuous; the violence of these storms is su h, that they seem to be of the nature of the West India hurricanes, and render the navigation of these parts very unsafe about that time of the year. These tempests are by our seamen usually termed, the breaking up of the monsoons. By reason of the shifting of these winds, such as sail in these seas are obliged to observe the seasons proper for their voyages; of which, if they miss, and the contrary monsoon sets in, they are forced to give up the hopes of accomplishing their intended voyage till the winds become favourable.

III. The third ocean, called Mare Pacificum, whose extent is equal to that of the other two, is that which is least known to our own or the neighbour nations; what navigation there is on it, is by the Spaniards, who go yearly from the coast of New Spain to the Manillas, and that only by one beaten track. What the Spanish authors say of the winds they find in their courses, and which is confirmed by the old accounts of Drake and Cavendish, and since by Schooten, who sailed the whole breadth of this sea in the south latitude of 15° or 16, is, that there is a great conformity between the winds of this sea and those of the Atlantic and Ethiopic seas; that is, that to the northward of the equator, the predominant wind is between the east and north-east; and to the southward thereof, there is a constant steady gale between the east and south-east; and that on both sides the line, with so much constancy, that they scarcely ever need to attend the sails; and with such strength, that it is usual to cross this vast ocean in ten weeks' time, which is about 130 miles a day; besides, it is said that storms and tempests are never known in these parts; so that some have thought it might be as short a voyage to Japan and China, to go by the Straits of Magellan, as by the Cape of Good Hope.

Mathematical Principles of Natural Philosophy. By ISAAC NEWTON, *Lucasian Professor of Mathematics at Cambridge. Analysed by Dr.* HALLEY.

THIS treatise is divided into three books, whereof the first two are entitled De Motu Corporum, the third De Systemate Mundi. The first begins with definitions of the terms made

use of, and distinguishes time, space, place, and motion, into absolute and relative, real and apparent, mathematical and vulgar: showing the necessity of such distinction. To these definitions are subjoined the laws of motion, with several corollaries from them; as concerning the composition and resolution of any direct force out of, or into any oblique forces, by which the powers of all sorts of mechanical engines are demonstrated; the laws of the reflection of bodies in motion after their collision; and the like.

These necessary præcognita being delivered, our author proceeds to consider curves generated by the composition of a direct impressed motion with a gravitation or tendency towards a centre: and having demonstrated that in all cases the areas at the centre, described by a revolving body, are proportional to the times, he shows how, from the curve described, to find the law or rule of the decrease or increase of the tendency or centripetal forces as he calls it, in different distances from the centre.

Of this there are several examples: as, if the curve described be a circle passing through the centre of tendency; then the force or tendency towards that centre is in all points as the fifth power, or squared-tube, of the distance from it reciprocally: if in the proportional spiral, reciprocally as the cube of the distance: if in an ellipse about the centre of it, directly as the distance. If in any of the conic sections about the focus, then he demonstrates that the vis centripeta, or tendency towards that focus, is in all places reciprocally as the square of the distance from it; and that according to the velocity of the impressed motion, the curve described is an hyperbola; if the body moved be swift to a certain degree, then a parabola; if slower, an ellipse, or a circle in one case. From this sort of tendency or gravitation it follows, likewise, that the squares of the times of the periodical revolutions are as the cubes of the radii or transverse axes of the ellipses.

All which being found to agree with the phænomena of the celestial motions, as discovered by the great sagacity and diligence of Kepler, our author extends himself upon the consequences of this sort of vis centripeta; showing how to find the conic section which a body shall describe when projected with any velocity in a given line, supposing the quantity of the said force known: and laying down several neat constructions to determine the orbs, either from the focus given, and two points or tangents; or, without it, by five points or tangents, or any number of points and tangents, making together five. He then shows how, from the time

given, to find the point in a given orbit answering to it; which he performs accurately in the parabola, and, by concise approximations, comes as near as he pleases in the ellipse and hyperbola: all which are problems of the highest concern in astronomy.

Next he lays down the rules of the perpendicular descent of bodies towards the centre, particularly in the case where the tendency to it is reciprocally as the square of the distance; and generally in all other cases, supposing a general quadrature of curve lines: upon which supposition, likewise, he delivers a general method of discovering the orbits described by a body moving in such a tendency towards a centre, increasing or decreasing in any given relation to the distance from the centre; and then with great subtilty he determines in all cases the motion of the apses, or of the points of greatest distance from the centre, in all these curves, in such orbits as are nearly circular. Showing the apses fixed, if the tendency be reciprocally as the square of the distance; direct in motion, in any ratio between the square and the cube; and retrograde, if under the square: which motion he determines exactly from the rule of the increase or decrease of the vis centripeta.

Next the motion of bodies in given surfaces is considered, as likewise the oscillatory motion of pendules; where it is shown how to make a pendulum vibrate always in equal times, though the centre or point of tendency be never so near; to which, the demonstration of Mr. Huygens de Cycloide is but a corollary. And in another proposition is shown the velocity in each point, and the time spent in each part of the arch described by the vibrating body. After this, the effects of two or more bodies, towards each of which there is a tendency, is considered; and it is made out that two bodies, so drawing or attracting each other, describe about the common centre of gravity curve lines, like to those they seem to describe about each other. And of three bodies, attracting each other, reciprocally as the square of the distance between their centres, the various consequences, are considered and laid down, in several corollaries of great use in explaining the phænomena of the moon's motions, the flux and reflux of the sea, the precession of the equinoctial points, and the like.

This done, our author, with his usual acuteness, proceeds to examine into the causes of this tendency or centripetal force, which, from undoubted arguments, is shown to be in all the great bodies of the universe. Here he finds that if a

sphere be composed of an infinity of atoms, each of which have a power which decreases in duplicate proportion of the distance between them; then the whole congeries shall have the like tendency towards its centre, decreasing, in spaces without it, in duplicate proportion of the distances from the centre; and decreasing within its surface, as the distance from the centre directly, so as to be greatest on the surface, and nothing at the centre: and though this might suffice, yet to complete the argument, there is laid down a method to determine the forces of globes composed of particles whose tendencies to each other decrease in any other ratio of the distances; which speculation is carried on likewise to other bodies not spherical, whether finite or indeterminate. Lastly, is proposed a method of explaining the refractions and reflections of transparent bodies from the same principles; and several problems solved of the greatest concern in the art of dioptrics.

Hitherto our author has considered the effects of compound motions in non-resisting media, or wherein a body once in motion would move equally in a direct line, if not diverted by a supervening attraction or tendency towards some other body. Here is demonstrated what would be the consequence of a resistance from a medium, either in the simple or duplicate ratio of the velocity, or else between both: and to complete this argument, is laid down a general method of determining the density of the medium in all places, which, with a uniform gravity tending perpendicularly to the plane of the horizon, shall make a project move in any curve line assigned; which is the 10th prop. lib. 2. Then the circular motion of bodies in resisting media is determined, and it is shown under what laws of decrease of density the circle will become a proportional spiral. Next, the density and compression of fluids is considered, and the doctrine of hydrostatics demonstrated; and here it is proposed to the contemplation of natural philosophers, whether the surprising phænomena of the elasticity of the air, and some other fluids, may not arise from their being composed of particles which fly each other; which being rather a physical than mathematical enquiry, our author forbears to discuss.

Next, the opposition of the medium, and its effects on the vibrations of the pendulum, are considered, which is followed by an enquiry into the rules of the opposition to bodies, as their bulk, shape, or density may be varied: here with great exactness is an account given of several experiments tried with pendula, in order to verify the foregoing speculation,

and to determine the quantity of the air's opposition to bodies moving in it.

From hence he proceeded to the undulation of fluids, the laws whereof are here laid down, and by them the motion and propagation of light and sound are explained. The last section of this book is concerning the circular motion of fluids, wherein the nature of their vortical motions is considered; and from thence the Cartesian doctrine of the vortices of the celestial matter carrying with them the planets about the sun is proved to be altogether impossible.

The third and last book is entitled Of the System of the World, wherein the demonstrations of the two former books are applied to the explication of the principal phænomena of nature: here the verity of the hypothesis of Kepler is demonstrated; and a full resolution given to all the difficulties that occur in the astronomical science; they being nothing else but the necessary consequences of the sun, earth, moon, and planets, having all of them a gravitation or tendency towards their centres proportional to the quantity of matter in each of them, and whose force abates in duplicate proportion of the distance reciprocally.

Here, likewise, are indisputably solved the appearances of the tides, or flux and reflux of the sea; and the spheroidical figure of the earth and Jupiter determined, from which the precession of the equinoxes, or rotation of the earth's axis, is made out, together with the retrocession of the moon's nodes, the quantity and inequalities of whose motion are here exactly stated à priore. Lastly, the theory of the motion of comets is attempted with such success, that in an example of the great comet which appeared in 1680, its motion is computed as exactly as we can pretend to give the places of the primary planets; and a general method is here laid down to state and determine the trajectorius of comets, by an easy geometrical construction; upon supposition that those curves are parabolic, or so near it that the parabola may serve without sensible error; though it be more probable, says our author, that these orbits are elliptical, and that after long periods comets may return again. But such ellipses are, by reason of the immense distance of the foci, and smallness of the latus rectum, in the parts near the sun where comets appear, not easily distinguished from the curve of the parabola; as is proved by the example produc[illegible]

The whole book is interspersed with lemmas [illegible] in geometry, and several new methods applied, which are well worth the considering; and it may be justly said, that so

reduced to rule, I mean the winds, whereby the surface of the water is licked up sometimes faster than it exhales by the heat of the sun; as is well known to those who have considered those drying winds which blow sometimes.

The Mediterranean receives these considerable rivers, the Iberus, the Rhone, the Tiber, the Po, the Danube, the Neister, the Borysthenes, the Tanais, and the Nile, all the rest being of no great note, and their quantity of water inconsiderable. These nine rivers, we will suppose each of them to bring down 10 times as much water as the river Thames, not that any of them is so great in reality, but to comprehend with them all the small rivulets that fall into the sea, which otherwise I know not how to allow for.

To calculate the water of the Thames, I assume that at Kingston bridge, where the flood never reaches, and the water always runs down, the breadth of the channel is 100 yards, and its depth three, it being reduced to an equality; in both which suppositions I am sure I take with the most. Hence the profile of the water in this place is 300 square yards; this multiplied by 48 miles, which I allow the water to run in 24 hours, at two miles an hour, or 84,480 yards, gives 25,344,000 cubic yards of water, to be evacuated every day; that is, 20,300,000 tons per diem; and I doubt not but in the excess of my measures of the channel of the river, I have made more than sufficient allowance for the waters of the Brent, the Wandel, the Lea, and Darwent, which are all that are worth notice, that fall into the Thames below Kingston.

Now if each of the aforesaid nine rivers yield 10 times as much water as the Thames does, it will follow that each of them yields but 20,300,000 of tons per diem, and the whole nine but 1,827,000,000 of tons in a day; which is but little more than $\frac{1}{4}$ of which is proved to be raised in vapour out of the Mediterranean in 12 hours' time.

On the Circulation of the Watry Vapours of the Sea, and the Origin of Springs. By Mr. E. Halley.

Some time since I showed an experiment of the quantity of water raised in vapour from the surface of the sea in a day's time, which was so far approved by some honourable members of this Society, that I have received their commands to prosecute those enquiries, and particularly in relation to the method used by nature to return the said vapours again into the sea; which is so justly performed, that in many hundreds of years

we are sufficiently assured that the sea has not sensibly decreased by the loss in vapour, nor yet abounded by the immense quantity of fresh water it receives continually from the rivers. To demonstrate this equilibrium of receipt and expence in the whole sea, is a task too hard for me to undertake, yet in obedience to those whom I have the honour to serve I shall here offer, what to me has hitherto seemed the most satisfactory account of this grand phenomenon. I have formerly attempted to explain the manner of the rising of vapour by warmth, by showing that if an atom of water were expanded into a shell or bubble, so as to be ten times as large in diameter as when it was water, such an atom would become specifically lighter than air, and rise as long as that flatus, or warm spirit, that first separated it from the mass of water, shall continue to distend it to the same degree; but that warmth decreasing, and the air growing cooler, and so specifically lighter, the vapours consequently will stop at a certain region of the air, or else descend; which may happen on several accounts, as will appear below. Yet I assert not that this is the only principle of the rise of vapours, and that there may not be a certain kind of matter whose conatus may be contrary to that of gravity; as is evident in vegetation, wherein the tendency of the sprouts is directly upwards, or against the perpendicular. But whatever be the true cause, it is in fact certain that warmth does separate the particles of water, and emit them with a greater velocity as the heat is more intense, as is evident in the steam of a boiling cauldron, wherein likewise the velocity of the ascent of the vapours visibly decreases till they disappear, being dispersed into and assimilated with the ambient air. Vapours being thus raised by warmth, let us, in the first place, suppose, that the whole surface of the globe were all water to a great depth, or rather, that the whole body of the earth were water, and that the sun had its diurnal course about it. It would follow, that the air of itself would imbibe a certain quantity of aqueous vapours, and retain them like salts dissolved in water, that the sun warming the air, and raising more plentiful vapours from the water in the day-time, the air would sustain a greater proportion of them, as warm water will hold more dissolved salts, which, upon the absence of the sun in the nights, would be all again discharged in dews, analogous to the precipitation of salts on the cooling of the liquors; nor is it to be thought that in such case there would be any diversity of weather, other than periodically, every year alike; the mixture of all

terrestrial, saline, heterogeneous vapours being taken away; which, as they are variously compounded, and brought by the winds, seems to be the causes of those various seasons which we now find. In this case the region of air, every where at the same height, would be equally replenished with the proportion of water it could contain, regard being only to be had to the different degree of warmth, from the nearness or distance of the sun; and an eternal east wind would blow all round the globe, inclining only to the same side of the east, as the latitude does from the equator, as is observed in the ocean between the tropics.

The Mediterranean is interspersed with wide and spacious tracts of land, with high ridges of mountains, as the Pyrenean, the Alps, the Apennine, the Carpathian in Europe; Taurus, Caucasus, Imaus, and several others in Asia; Atlas, and the Montes Lunæ, with other unknown ridges in Africa, whence come the Nile, the Niger, and the Zaire; and in America the Andes, and the Apalatean mountains, each of which far surpass the usual height to which the aqueous vapours of themselves ascend, and on the tops of which the air is so cold and rarefied, as to retain but a small part of those vapours brought thither by the winds. Those vapours, therefore, that are raised copiously in the sea, and by the winds carried over the low lands to those ridges of mountains, are there compelled by the stream of the air to mount up with it to the tops of the mountains, where the water presently precipitates, gleeting down by the crevices of the stone, and part of the vapour entering into the caverns of the hills, they are collected, as in an alembic, into the basins of stone they find there, which being once filled, all the overplus of water that comes thither runs over by the lowest place, and breaking out by the sides of the hills forms single springs; many of these running down by the valleys or guts between the ridges of hills, and coming to unite, form little rivulets or brooks; many of these again meeting in one common valley, and gaining the plains, being grown less rapid, they become a river; and many of these being united in one common channel, make such streams as the Rhine, the Rhone, and the Danube; which latter one would hardly think the collection of water condensed out of vapour, unless we consider how vast a tract of ground that river drains, and that it is the aggregate of all those springs which break out on the south side of the Carpathian mountains, and on the north side of the immense ridge of the Alps, which is one continued chain of mountains

from Switzerland to the Black Sea. And it may generally pass for a rule, that the magnitude of a river, or the quantity of water it discharges, is proportionable to the length and height of the ridges, from whence its fountains arise.

Thus, then, is one part of the vapours, blown upon the land, returned by the rivers into the sea, from whence they came. Another part, by the cool of the night, falls in dews, or else in rains, again into the sea, before it reaches the land, which is by much the greatest part of the whole vapour, because of the great extent of the ocean, which the motion of the winds does not traverse in a very long space of time. And this is the reason why the rivers do not return so much into the Mediterranean as is extracted in vapour. A third part falls on the lower lands, and is the pabulum of plants, where yet it does not rest, but is again exhaled in vapour by the action of the sun, and is either carried by the winds to the sea, to fall in rain or dew there, or else to the mountains, to be there turned into springs; and though this does not immediately happen, yet after several vicissitudes, of rising in vapour and falling in rain or dews, each particle of the water is at length returned to the sea from whence it came. Add to this, that the rain waters, after the earth is fully sated with moisture, by the valleys or lower parts of the earth finds its way into the rivers, and so is compendiously sent back to the sea.

After this manner is the circulation performed, and I doubt not but this hypothesis is more reasonable than that of those who derive all springs from the rain waters, which yet are perpetual and without diminution, even when no rain falls for a long space of time; or than that which derives them from a filtration of the sea waters through certain imaginary tubes or passages within the earth, wherein they lose their saltness. This latter hypothesis, besides many others, labours under this principal absurdity, that the greatest rivers have their most copious fountains farthest from the sea, and whither so great quantities of fresh water cannot reasonably be derived any other way than in vapour. This, if we may allow final causes, seems to be the design of the hills, that their ridges being placed through the midst of the continents, might serve as it were for alembics to distil fresh water for the use of man and beast, and their heights to give a descent to those streams to run gently, like so many veins of the macrocosm, to be the more beneficial to the creation.

Now this theory of springs is not a bare hypothesis, but founded on experience, which it was my luck to gain in my stay at St. Helena, where in the night-time, on the tops of

the hills, about 800 yards above the sea, there was so strange a condensation, or rather precipitation of the vapours, that it was a great impediment to my celestial observations; for in the clear sky the dew would fall so fast as to cover, each half quarter of an hour, my glasses with little drops, so that I was necessitated to wipe them so often, and my papers on which I wrote my observations would immediately be so wet with the dew, that it would not bear ink.

A Letter from Hans Sloane, *M. D., with Accounts of the Earthquakes in Peru, Oct.* 20. 1687: *and at Jamaica, Feb.* 19. 1687–8; *and June* 7. 1692.

No. I. *A Letter from Father Alvarez de Toledo, a Franciscan Friar, dated Oct.* 20. 1687. — Oct. 20. at 4 o'clock in the morning came on a dreadful earthquake and noise, by which some houses fell, and some persons were killed under their ruins. At five o'clock the same morning was another shake, with the like noise. At six o'clock the aforesaid morning, when we thought we had been all in safety, came another shake, with great fury and rushing noise; the sea with great bellowings rushed beyond its bounds, the bells rang of themselves, and every building thrown down. Callao, Canete, Pisco, Chancay, and Los Chorillos, are all ruined. More than 5000 dead bodies are found, and more are found daily, so that their number is not known.

No. II. *By Dr. Sloane.* — The inhabitants of Jamaica expect an earthquake every year. Some are of opinion, that they follow the great rains. One of them happened on Sunday the 19th of Feb. 1687–8, about eight in the morning. I found in a chamber, one story high, the cabinets and several other moveables on the floor to reel, as if people had raised the foundations of the house. Being in a high brick house, I made what haste I could to get out; but before I had passed through two rooms, and got to the stair-case, it was over. It came by shocks; there were three of them, with a little pause between. It lasted about a minute of time in all; and there was a small noise accompanied it. This was generally felt all over the island at the same time, or near it: some houses therein being cracked and very near ruined, others being uncovered of their tiles; very few escaped some injury. The ships in the harbour at Port-Royal felt it

No. III *On the terrible Earthquake at Port-Royal, in Jamaica, June* 7. 1692. — The terrible earthquake which happened the 7th instant, between 11 and 12 o'clock at noon,

shook down and drowned nine tenths of the town of Port-Royal in two minutes' time, and all near the wharf-side in less than one minute; very few escaped there. I lost all my people and goods, my wife and two men, Mrs. B. and her daughter. One white maid escaped, who gave me an account, that her mistress was in her closet, two pair of stairs high, and she was sent into the garret, where was Mrs B. and her daughter, when she felt the earthquake, and bid her take up her child and run down; but turning about, met the water at the top of the garret stairs; for the house sunk down right, and is now near 30 feet under water. My son and I went that morning to Liguania: the earthquake took us in the mid-way between that and Port-Royal, where we were near being overwhelmed by a swift rolling sea, six feet above the surface, without any wind; but being forced back to Liguania, I found all the houses even with the ground. The earth continues to shake five or six times in 24 hours, and often trembling. Great part of the mountains fell down, and fall daily.

No. IV. *From Jamaica, dated Sept.* 23. 1692.— We have had a dreadful mortality since the great earthquake (for we have little ones daily); almost half the people that escaped at Port-Royal are since dead of a malignant fever, from the change of air, want of dry houses, warm lodging, proper medicines, and other conveniences.

No. V. *Another Account of the Earthquake of June* 7. 1692.— Great part of Port-Royal is sunk; so that where the wharfs were is now some fathoms of water: all the street where the church stood is overflowed, that the water stands as high as the upper rooms of those which are standing. The earth when it opened and swallowed up people, some rose in other streets, some in the middle of the harbour, and were saved; though, at the same time, I believe there were lost about 2000 whites and blacks. At the north about 1000 acres of land sunk, and 13 people with it; all our houses thrown down all over the island, that we were forced to live in huts. The two great mountains at the entering into Sixteen-Mile-Walk fell and met, and stopped the river; so that it was dry from that place to the Ferry for a whole day; and vast quantities of fish taken up, which was greatly to the relief of the distressed. At Yellows a great mountain split, and fell into the level land, and covered several settlements, and destroyed 19 white people. One of the persons, whose name was Hopkins, had his plantation removed half a mile

from the place where it formerly stood. Of all wells, from a fathom to six or seven, the water flew out at the top, by the great motion of the earth Since then, it has continued shaking sometimes two or three times in a day. Our people settled a town at Liguania side, and there are about 500 graves already, and people every day are dying still.

No VI. *From the same Place, and on the same Earthquake.* — On Tuesday, the 7th of June, 1692, between 11 and 12 at noon, at Port-Royal, we felt the house shake, and saw the bricks begin to rise in the floor. Immediately we ran out, and saw the houses swallowed up, or thrown on heaps. The sand in the street rose like the waves of the sea, lifting up all persons that stood upon it, and immediately dropping down into pits; and at the same instant a flood of water rushed in, throwing down all who were in its way; some were seen catching hold of beams and rafters of houses, others were found in the sand that appeared when the water was drained away, with their legs and arms out. As soon as the shock was over, I endeavoured to go towards my house, on the ruins of the houses that were floating on the water, but could not: at length I got a canoe, and rowed up the great sea-side towards my house, where I saw several men and women floating upon the wreck out at sea; and taking in as many as I could. I rowed on till I came where I thought my house had stood, but could not hear of either my wife or family. Next morning I went from one ship to another, till at length I met with my wife and two of my negroes She told me, when she felt the house shake, she ran out, and called all within to do the same: she was no sooner out, but the sand lifted up: and her negro women grasping about her, they both dropped into the earth together; and at the same instant the water coming in, rolled them over and over, till at length they caught hold of a beam, where they hung, till a boat came from a Spanish vessel, and took them up.

Several ships were overset and lost in the harbour, and some thrown on the land. A hideous rumbling was heard in the mountains; so that it frightened many negroes that had been run away some months from their masters, and made them return, and promise never to run away again. The water that issued from the Saltpans Hills forced its passage out from the hill in 20 or 30 several places; some with such violence, that had so many sluices been drawn up at once, they could not have run with greater force, and most of them six or seven yards high from the foot of the hill; and the water was brackish. It continued running that afternoon, all

night, and till next morning about sun-rise, at which time the Saltpans were quite overflowed.

The mountains between Spanish Town and Sixteen-Mile-Walk, as the way lies along the river, about the mid-way they are almost perpendicular; those two mountains, in the violent shake of the earthquake, joined together, which stopped the passage of the river, and forced it to seek another, which was a great way in and out among the woods and savannas; and it was nine days before the town had any relief from it: insomuch that before it came, the people were in thoughts of removing into the country, concluding it had been sunk, as Port-Royal was. The mountains along the river are so thrown on heaps, that all people are forced to go by Guanaboa to Sixteen-Mile-Walk.

The mountains at Galloes fared no better than those of Sixteen-Mile-Walk, a great part of one of them falling down, drove all the trees before it; and at the foot of the mountain there was a plantation that was wholly overthrown and buried in it.

No. VII. *Some more Particulars of the same.*—As to the mountains in Leguanee, they fell in several places, and in some very steep; but the steepest mountain that we heard fall, was that at Gallowes, which occasioned much damage. The water in the streets of Port-Royal did not spout up, as you have heard; but in the violent shake the sand cracking and opening, in several places where people stood, they sunk into it; and the water boiled out of the sand, that covered many, and saved others.

No. VIII. *Some other Particulars of the same.*—The year 1692 began in Jamaica with very dry and hot weather, which continued till May, when there was very blowing weather, and much rain to the end of the month, from which time, till the time of the earthquake, it was very hot, calm, and dry; and on Tuesday the 7th of June, about 40 minutes past eleven in the forenoon, it being then a very hot and fine day, scarcely a cloud to be seen in the sky, or a breath of air to be felt, happened that great shake, so fatal to this place, and to the whole island, which, for its violence and strange effects, may perhaps be compared with the greatest that ever yet happened in the world, and may as well deserve the memory of future ages.

It began with a small trembling, so as to make people think there was an earthquake, which thoughts were immediately confirmed by a second shake something stronger, accompanied all the while with a hollow rumbling noise, almost like

that of thunder, which made them begin to run out of their houses. But, alas! this was but short warning for them to provide for their safety; for immediately succeeded the third shock, which in less than a minute's time shook the very foundation of Port-Royal, so that at least two parts in three of the houses, and the ground whereon they stood, and most part of those who inhabited them, all sunk at once quite under water: and on the place which was left, and is now standing, shook down and shattered the houses in so violent a manner, that at our landing it looked like a heap of rubbish, scarcely one house in ten left standing, and those so cracked and shattered, that but few of them were fit, or thought safe to live in. All those trees which were next the water, towards the harbour-side where there were excellent wharfs, close to which ships of 700 tons might lie and deliver their lading, where were the best store-houses and conveniences for merchants, where were brave stately buildings, where the chief men of the place lived, and which were in all respects the principal parts of Port-Royal, now lie in four, six, or eight fathoms water. That part which is now standing is part of the end of that neck of land which runs into the sea, and makes this harbour, and is now a perfect island; the whole neck of land from the port of Port-Royal now standing, to the pallisadoes, or other end of Port-Royal towards the land, which is above a quarter of a mile, being quite discontinued and lost in the earthquake; and is now also, with all the houses, quite under water. This part of Port-Royal which is now standing is said to stand upon a rock: but, alas! the strange rents and tearings of the mountains here sufficiently evince, that rocks and sand are equally unable to withstand the force of a violent earthquake. The ground heaved and swelled like a rolling swelling sea; by which means several houses now standing were shuffled and moved some yards from their places.

One whole street is said to be twice as broad now as before the earthquake; and in many places the ground would crackle, and open and shut quick and fast: of which small openings have been seen 200 or 300 at one time, in some whereof many people were swallowed up; some the earth caught by the middle, and squeezed to death; the heads of others only appeared above ground; some were swallowed quite down, and cast up again by great quantities of water; others went down, and were never more seen. These were the smallest openings. Others, that were larger, swallowed up great houses; and out of some gapings would issue whole

rivers of water, spouted up a great height into the air, which seemed to threaten a deluge to that part of Port-Royal which the earthquake seemed to favour, accompanied with offensive smells, by means of which openings, and the vapours at that time emitted from the earth into the air, the sky, which before was clear and blue, was in a minute's time become dull and reddish, looking like a red-hot oven.

All these dreadful circumstances occurring at once, accompanied with prodigious loud noises from the mountains, occasioned by their falling, &c. and also a hollow noise under ground, and people running from one place to another distracted with fear, made the whole so terrible, that people thought the dissolution of the whole frame of the world was at hand. Indeed, it is melancholy now to see the chimnies and tops of some houses, and the masts of ships, appear above water; and when one first comes ashore, to see so many heaps of ruins; to see so many houses shattered, some half fallen down, the rest desolated and without inhabitants; to see where houses have been swallowed up, some appearing half above ground, and of others the chimnies only; but above all, to stand on the sea-shore, and to look over that part of the neck of land, which for above a quarter of a mile was quite swallowed up; there, where once brave streets of stately houses stood, appearing now nothing but water, except here and there a chimney, and some parts and pieces of houses.

And though Port-Royal was so great a sufferer by the earthquake, yet it left more houses standing there than in all the island besides, all over which it was said to rage more furiously than at Port-Royal; for it was so violent in other places, that people could not keep their legs, but were thrown on the ground, where they lay on their faces with their arms and legs spread out, to prevent being tumbled and thrown about by the almost incredible motion of the earth, like that of a great sea. It scarcely left a planter's house or sugar-work standing all over the island: I think it left not a house standing at Passage-Fort, and but one in all Liganee, and none in St. Jago, except a few low houses, built by the wary Spaniards. And it is not to be doubted, but that had there been 500 or 5000 towns in Jamaica, the earthquake would have ruined every one. In several places in the country the earth gaped prodigiously on the north side, the planters' houses, with the greatest part of their plantations, were swallowed, houses, people, trees, all up in one gape; instead of which, appeared for some time after a great pool or lake of water, covering above 1000 acres, which is since dried up,

and now is nothing but a loose sand or gravel, without any the least mark left whereby one may judge that there ever had stood a tree, house, or any thing else.

In Clarendon precinct the earth gaped, and spouted up with a prodigious force great quantities of water into the air, above 12 miles from the sea; and all over the island there were abundance of gapings of the earth, many thousands. But in the mountains are said to be the most violent shakes of all; and it is a generally received opinion, that the nearer to the mountains, the greater the shake. Indeed, they are strangely torn and rent; insomuch, that they seem to be of quite different shapes now from what they were, especially the blue, and other high mountains; thus breaking one mountain, and thereof making two or three; and joining two mountains, and making thereof one, closing up the unhappy valley between. And at Yallowes particularly, some families, who lived between two mountains, were shut up and buried under them. Not far from which place, part of a mountain, after having made several leaps or moves, overwhelmed a whole family, and great part of a plantation, lying a mile off. And a large high mountain, near Port-Morant, near a day's journey over, is said to be quite swallowed up; and in the place where it stood there is now a great lake of four or five leagues over. Those things happened in lower mountains: but in the blue mountains, and the neighbouring ones, from whence came those dreadful roarings, terrible and amazing to all that heard them, may be reasonably supposed to be many strange alterations of the like nature: but those wild desert places, being very rarely or never visited by any persons, we are yet ignorant of what happened there; but the astonishing noises that came from thence, and their miserable, shattered appearance, show what havoc has been there made. There one may see where the tops of great mountains have fallen, sweeping down all the trees, and every thing in their way, and making a path quite from top to bottom; and other places which seem to be peeled and bare a mile together; which vast pieces of mountains, with all the trees thereon, falling together in a huddled and confused manner, stopped up most of the rivers for about 24 hours; which afterwards having found out new passages, brought down into the sea, and this harbour, several hundred thousand tons of timber, which would sometimes float in the sea in such prodigious quantities, that they looked like moving islands. I have seen several of those large trees on this shore, all deprived of their bark and branches, and generally very much torn by the

rocky passages, through which, by the force of a falling stream, and their own weight, they might be supposed to be driven. One great trunk of a tree, particularly, I have seen pressed as a sugar-cane after it has passed the mill.

Some are of opinion that the mountains are sunk a little, and are not so high as they were: others think the whole island is sunk something by the earthquake. Port-Royal is said to be sunk a foot; and in many places in Liganee, I have been told are wells, which require not so long a rope to draw water out of them now, as before the earthquake, by two or three feet, which seems a sort of proof, that either the land is sunk or the sea risen, the former of which seems most probable. Two gentlemen happened at the time of the earthquake to be in Liganee, by the sea-side; where at the time of the great shake the sea retired from the land in such sort, that for 200 or 300 yards the bottom of the sea appeared dry, whereon they saw lie several fish, some of which one of the gentlemen ran and took up, and in a minute or two after the sea rapidly returned again, and overflowed great part of the shore. At Yallhouse the sea is said to have retired above a mile. It is thought there were lost in all parts of the island 2000 people; and had the shock happened in the night, very few would have escaped alive; and those that had would in all probability have been knocked in the head by the negroes, and the island to all intents and purposes quite ruined.

It is observed, that since the earthquake, the land-breezes often fail us, and instead thereof, the sea-breezes often blow all night; a thing rarely known before, but since common. In Port-Royal, and in many places all over the island, much sulphureous combustible matter has been found, supposed to have been thrown out, on the opening of the earth, which on the first touch of fire would flame and burn like a candle.

After the great shock, those who escaped got on board the ships in the harbour, where many continued about two months after: the shocks all that time were violent, and frequent; sometimes two or three in an hour's time, accompanied with frightful noises, both from under the earth, and from the continual falling and breaking of the mountains.

Account of the Giants' Causeway, in the North of Ireland. By the Rev. Dr. Samuel Foley.

The Giants' Causeway is about eight English miles north-east from the town of Colcrain, and about three from the

Bush-Mills, almost directly north. It runs from the bottom of a high hill into the sea, how far is not known; but at low-water its length is about 600 feet, and its breadth in the broadest place 240 feet, in the narrowest 120 feet; it is also very unequal in height, being in some places about 36 feet high above the level of the strand, and in other places about 15 feet.

It consists of many thousand pillars, which stand mostly perpendicular to the plane of the horizon, and close to one another; but we could not discern whether they run down under ground like a quarry or not. Some of the pillars are very long, and higher than the rest; others short and broken: some for a pretty large space of an equal height, so that their tops make an even, plane surface; many of them are imperfect, cracked, and irregular; others entire, uniform, and handsome, and these of different shapes and sizes.

We found none square, but almost all pentagonal, or hexagonal; only a few had seven sides; and many more pentagons then hexagons; but they are all irregular, none having their sides of equal breadth; some of the pillars are 15, some 18 inches, some again two feet in diameter; none of them are one entire stone, but every pillar consists of several joints, or pieces, of which some are six, some 12, some 18 inches, some two feet deep. These pieces lie close upon one another, not joining with flat surfaces, but one of them is always concave in the middle, the other convex. These joints are not always placed alike; for in some pillars the convexity is always upwards, and in others it is always downwards. They always lie as close as possible for one stone to lie on another, so that on the outside of the pillars you can only discern the crack that joins the two stones. When you force them asunder, both the concave and convex surfaces are very smooth, as are also the sides of the pillars, which touch each other, being of a whitish free-stone colour, but a finer and closer grit; whereas on breaking some pieces off them, the inside appears like dark marble.

The pillars stand so close one to another, that a knife can hardly be thrust in between their sides; and though some have five sides, and others of them six, yet their contexture is so adapted, that there is no vacuity between them: the inequality of the numbers of the sides of the pillars being often in a very surprising and wonderful manner, throughout the whole causeway, compensated by the inequality of the breadths and angles of those sides; so that the whole at a little distance looks very regular; and where in many places

a good number of the pillars are exactly of the same height, the superficies of their tops looks very like the pavements that are in some gentlemen's halls.

Every single pillar retains its own thickness, and angles, and sides, from top to bottom. Those which seem to be entire, as they were originally, are at the top flat and rough; those which lie low to the sea are washed smooth; and others, that seem to have their natural tops blown or washed off, are some concave, and others convex.

Account of the Mischief which befell the Inhabitants of the Isle of Sorea, near the Moluccas.

In the beginning of the easterly season, the isle of Sorea, situated towards the south-east of these islands, consisting for the most part of one mountain, which now is more terribly shaken than ever before, casting out abundance of fire and smoke, only with some short intermissions. And when the easterly wind had blown about six or seven weeks, till about the 4th of June, the inhabitants being almost so far used to the trembling and casting up of fire that they were careless, the mountain Sorea began early in the morning to cast out more fire than ordinary, which continued for five or six days, during which it was dark and cloudy weather, till at last it brought forth not only a most prodigious flame, but also such a black and sulphureous vapour, that the inhabitants of Hislo, a village in the western part of the island, and nearest to the opening of the mountain, were wholly covered by it, and afterwards followed a whole stream of burning brimstone, which consumed many that could not escape. Afterwards the inhabitants perceived that a part of the mountain was sunk down, and three or four days after another part; and so from time to time, until the burning lake was become almost half the space of the island Wherefore the inhabitants went on board their vessels and boats, from whence they perceived that huge pieces of the mountain fell into this fiery lake, as into a bottomless pit, with a most prodigious noise, as if a large cannon were discharged. It was remarkable, that the more vehement the fire was, the less the island was shaken.

The inhabitants of another town, called Woroe, upon the east side of the island, not thinking themselves in so great danger, the opening or fiery lake being yet at some distance, remained a month longer, until they saw the same continually approaching them: they observed that when great pieces fell down, and that the lake became wider, the noise was so much

the greater, so that they saw no likelihood but that all the island would be swallowed up; wherefore they unanimously transported themselves to Banda, leaving all their moveables for want of vessels.

On Chylification. By Mr. WILLIAM COWPER.

THE cutting-teeth are first employed in dividing the food. When a proportionable piece is thus taken into the mouth, the lower jaw is variously moved by its proper muscles, and mastication is begun, and carried on by the assistance of the tongue, cheeks, and lips; the first two still applying the less divided parts of the aliment to the dentes molares, till there is an equal comminution of all its parts. At the same time several of the muscles, employed in the motion of the lower jaw, are also serviceable in promoting the saliva or spittle, separated from the blood by the parotid glands; those of the lower jaw, and under the tongue into the mouth, the salival glands of the cheeks and lips also contributing their juices, do altogether join with the masticated aliment, before or at the same time it is made fit to be swallowed; which action is called deglutition.

Deglutition is thus performed: the aliment, as well what is fluid as that masticated, being lodged on the tongue, which somewhat hollows itself, by means of its own proper muscular fibres, for the more commodious entertaining the larger quantity, its tip and sides are applied to the insides of all the teeth of the upper jaw, the tongue is suddenly drawn up by the musculi styloglossi and myloglossus, together with those muscles which pull the os hyoides upwards, at the same time the fauces are also drawn up, and their cavity enlarged by the musculi stylopharyngei; and about two thirds of the superior surface of the tongue is adequately applied to the roof of the mouth; the epiglottis, from its position being consequently depressed, thereby covers the glottis or rimula of the larynx, and prevents any part of the aliment from descending into the windpipe. In this part of the action of deglutition, the glands under the tongue, and excretory ducts of those of the lower jaw, are compressed, and their separated liquors or spittle discharged by their papillæ, situated at the lower part of the frænum or ligament of the tongue; and this is done by the musculus mylohyoideus. When the aliment is thus forced into the fauces, or upper part of the gula, at the same time the gargareon, with the uvula, are drawn upwards and backwards by the musculi sphænostaphyli, by which means

any part of the aliment is hindered from ascending into the foramina narium; the fauces by the musculus pterygopharyngeus and œsophageus are contracted; by which the aliment is not only compressed into the gula, but the matter separated from the blood by the glands of the fauces, especially of those large ones called tonsillæ, is forced out of their cells or excretory ducts, to join with it in its descent to the stomach by the gula, through which latter it passes, by the action of its muscular fibres.

The aliment, thus impregnated with saliva in mastication and deglutition, being received into the stomach, there meets with a juice separated from the blood by the glands of that part, whose excretory ducts open into the cavity of the stomach: by the commixture of these liquors, whether of the saliva or juice of the stomach, a proper menstruum is composed, by which the parts of the aliment are still more and more divided, by its insinuating into their pores, by which the air, before imprisoned in their less divided parts, is not only more disentangled, but by the natural heat it must necessarily suffer such a rarefaction, as that the whole stomach becomes still more and more distended: hence it is we have less appetite some time after eating than we had immediately after; hence also arise those frequent eructations from divers aliments, as old pease, cabbage, and other vegetables. Though we have not used the word fermentation, yet we do not suppose the dissolution of the aliment within the stomach can be done, at least without an intestine motion of its particles with the menstruum: but we have omitted that term, because it may be apt to lead us into an idea of a greater conflict than in truth there really is.

At the same time, when this intumescence and agitation of the matter is made in the stomach, the contents of the neighbouring excretory ducts, viz. the bile in the gall-bladder, the liver ducts, and the pancreatic juice in the ductus pancreaticus,* are compressed into the duodenum, through the extension of the stomach itself: the refluent blood of the stomach at that instant being, in some measure, retarded, whence the muscular fibres are more liable to be contracted.

Nor can we conceive how the liquor of the stomach, after uniting with the saliva and aliment, should be still so plentifully excreted from the glands of that part, as to irritate its internal membrane, and excite its muscular fibres to contract, since the muscles of the abdomen would in like manner, as in vomiting, be drawn into a consent of co-operating, and the aliment would be forcibly rejected by the mouth: besides,

should the liquor of the stomach prove so prejudicial in chylification, what would the case be, immediately on the discharge of all its contents. The irritation the stomach undergoes in hunger appears only to arise from an accumulation of the saliva in the stomach, in conjunction with the liquor of the glands of that part; hence it is we rather discharge the spittle at that time by the mouth, than to suffer any more of it to descend into the stomach; hence proceeds what is called the watering of the mouth; hence, also, when the saliva is vitiated, the appetite is depraved.

The stomach, by means of its muscular fibres, contracting itself, gradually discharges its contents by the pylorus into the duodenum, in which gut, after a small semicircular descent, it meets with the pancreatic juice and bile; both which joining with it, renders some parts of the aliment more fluid, by still disuniting the grosser parts from the more pure; and here chylification is made perfect. The bile which abounds with lixivial salts, and is apt to mix with the grosser parts of the concocted aliment, stimulates the guts, and deterges or cleanses their cavities of the mucous matter, separated from the blood by glands of the guts, and lodged in their cavities; which not only moistens the insides of the guts but defends the mouths of the lacteals from being injured by foreign bodies, which often pass that way.

The contents of the intestines moving still on by means of the peristaltic or wormlike motion of the guts, whilst those thinner parts fitted for the pores of the lacteal vessels, called chyle, is absorbed by them, the thicker parts move still more slowly on, and by the many stops they continually meet with by the connivent valves, all the chyle or thinner parts are at length entirely absorbed: the remains, being merely excrementitious, are only fit to be excluded by stool.

Microscopical Observations of vast Numbers of Animalcules seen in Water. By JOHN HARRIS, *M.A. Rector of Winchelsea.*

"JULY the 7th, 1694, I examined a small drop of some rain-water which had stood in a gallipot in my window for about two months. I took it with the head of a small pin from the discoloured surface of the water, and observed in it four sorts of animals. In the clear part of the drop were two kinds, and both very small. Some were of the figure of ants' eggs; these were in continual and swift motion; and I find that this kind of oval figure is the most common to the animalcules

found in liquors. The other species, that were in the clear part of the drop, were much more oblong; about three times as long as broad; these were exceedingly numerous, but their motion was slow in comparison of the former.

In the thick part of the drop, for the water had contracted a thickish scum, I found also two species of animals: as, a kind of eels, like those in vinegar, but much smaller, and with their extremities sharper; these would wriggle out into the clear part, and then suddenly return back again, and hide in the thick and muddy part of the drop, much like common eels in the water. I saw here also an animal like a large maggot, which would contract itself up into a spherical figure, and then stretch itself out again; the end of its tail appeared with a forceps, like that of an ear-wig, and I could plainly see it open and shut its mouth, from whence air-bubbles would frequently be discharged. Of these I could number about four or five, and they seemed to be busy with their mouths, as if in feeding.

These four kinds of living creatures I found afterwards also in many other drops of the same corrupted water, viz. in its film or scum, which was on the surface; for under that, in the lower parts of the water, I could never find any animals at all, unless when the water was disturbed, and the surface shaken down into, and mingled with, the lower parts.

April 27th, 1696. With a much better microscope I examined some rain-water, which had stood uncovered a pretty while, but had not contracted any such thick and discoloured scum as that before mentioned had. In this, where it was clear, I could not find any animals at all; but a little thin white scum, which like grease began to appear on the surface, I found to be a congeries of exceedingly small animalcules of different shapes and sizes, much like those produced by steeping barley in water.

At the same time I looked on a small drop of the green surface of some puddle-water: this I found to be altogether composed of animals of several shapes and magnitudes; but the most remarkable were those which I found gave the water that green colour, and were oval creatures, whose middle part was of a grass green, but each end clear and transparent. They would contract and dilate themselves, tumble over and over many times together, and then shoot away like fishes; their head was at their broadest end, for they still moved that way. They were very numerous, but yet so large, that I could distinguish them very plainly with a glass that did not magnify very much. Among these were

interspersed many other smaller and transparent animals, like those just mentioned, as found in the whitish scum that was on some rain-water, which had stood a while uncovered.

April the 29th, 1696, I found another sort of creatures in the water, some of which I had kept in a window in an open glass. They were as large as three of the others, with the green border about their middles, but these were perfectly clear and colourless.

I then also examined more accurately the belts or girdles of green which were about the above animals, and found them to be composed of globules so like the roes or spawn of fishes, that I could not but fancy they served for the same use in these little animals; for I found now, since April 27., many of them without any thing at all of that green belt or girdle: others with it very much, and that unequally diminished, and the water filled with a vast number of small animals, which before I saw not there, and which I now considered as the young animated fry, which the old ones had shed. I continued looking on them at times, for two days, during which time the number of the old ones, with the green girdles, decreased more and more; and at last I could not see one of them so encompassed, but they were all clear and colourless from end to end

May the 18th, 1696, I looked on some of the surface of puddle-water, which was bluish, or rather of a changeable colour, between blue and red. In a large quantity of it I found prodigious numbers of animals, and of such various sizes, that I could not but admire their great number and variety; but among those were none with those girdles before mentioned, either of green or any other colour.

I then also examined the surface of some other puddle-water, that looked a little greenish; and this I found stocked with such infinite numbers of animals as I never yet saw, except in the genitura masculinâ of some creatures. Among these there were many of a greenish colour, but they all moved about so swiftly, and were so near to each other, that I could not distinguish whether the green colour were all over their bodies, or whether it were only round their middles in girdles, as before; but from the roundness of their figure and their smallness, I judged that they chiefly consisted of the young animated spawn of the above-mentioned kind of animals. I found that the point of a pin dipped in spittle would presently kill them all.

In the surface of some mineral chalybeate water, which had stood in a phial unstopped for about three weeks, I saw two

kinds of animals, one exceedingly small, and the other very large; which latter sort had on the tail something like fins: there were but very few of either sort. The compounded salt or vitriol of the water was shot into pretty figures, but all irregular. They looked like a small heap of little sticks, laid across each other at all angles and positions, only they were transparent, and a little greenish, as crystals of a chalybeate nature used to be.

I have infused whole pepper-corns, bay-berries, oats, barley, and wheat, in water, whose scum, after two or three days, has afforded animals, as has been often already found by others, at least as to some of them; but I found the greatest numbers and variety in wheat and barley-water, and the fewest in that wherein bay-berries had been steeped.

How such vast numbers of animals can be thus, as it were at pleasure, produced, without having recourse to equivocal generation, seems a very great difficulty to account for? But though the solving of it that way makes short work of the matter, for it is easy enough to say they are bred there by putrefaction, yet the asserting equivocal generation seems to me to imply more absurdities and difficulties than perhaps may appear at first sight.

On the great Age of Henry Jenkins; in a Letter from Mrs. Ann Savile to Dr. Tancred Robinson, F.R.S

When I came first to live at Bolton, it was told me, there lived in that parish a man near 150 years old; that he had sworn as witness in a cause at York to 120 years, which the judge reproving him for, he said he was butler at that time to Lord Conyers, and they told me, that it was reported his name was found in some old register of the Lord Conyer's menial servants. Being one day in my sister's kitchen, Henry Jenkins coming in to beg an alms, I had a mind to examine him: I told him he was an old man who must soon expect to give an account to God of all he did or said; and I desired him to tell me very truly how old he was; on which he paused a little, and then said, that, to the best of his remembrance, he was about 162 or 163. I asked him what kings he remembered; he said Henry VIII.; I asked him what public thing he could longest remember? he said Flodden-field. I asked whether the king was there? he said, No, he was in France, and the Earl of Surry was general. I asked him how old he might be then? he said, he believed between 10 and 12; "for," says he, "I was sent to North

allerton with a horse-load of arrows, but they sent a bigger boy from thence to the army with them." I thought by these marks I might find something in histories, and looking in an old chronicle, I found that Flodden-field was about 152 years before; so that if he was 10 or 11 years, he must be 162 or 163, as he said, when I examined him. I found by the book, that bows and arrows were then used, and that the earl he named was then general, and that King Henry VIII. was then at Tournay; so that I don't know what to answer to the consistences of these things, for Henry Jenkins was a poor man, and could neither write nor read. There were also four or five in the same parish, that were reputed all of them to be 100 years old, or within two or three years of it, and they all said he was an elderly man ever since they knew him; for he was born in another parish, and before any register was in churches, as it is said; he told me then, too, that he was butler to the Lord Conyers, and remembered the abbot of Fountains-abbey very well, who used to drink a glass with his lord heartily, and that the dissolution of the monasteries he said he well remembered. Ann Savile.

This Henry Jenkins died Dec. 8. 1670, at Ellerton, on Swale. The battle of Flodden-field was fought on the 9th of Sept. 1513. Henry Jenkins was 12 years old when Flodden-field was fought, so that he lived 169 years. Old Parr lived 152 years nine months, so that Henry Jenkins outlived him by computation 16 years, and was the oldest man born on the ruins of this postdiluvian world.

This Henry Jenkins, in the last century of his life, was a fisherman, and used to wade in the streams; his diet was coarse and sour; but towards the latter end of his days he begged up and down; he has sworn in chancery and other courts, to above 140 years' memory, and was often at the assizes at York, whither he generally went a-foot; and I have heard some of the country gentlemen affirm, that he frequently swam in the rivers after he was past the age of 100 years.

Microscopical Observations on the Seeds of Figs, Strawberries, &c. By Mr. Leuwenhoek.

I have taken a great deal of pains, to see the plant in the seed of a fig, yet I could never accomplish it, for it seemed to me that the figs were not perfectly ripe, when they were pulled off and turned up, to be sent beyond seas. But having some lately which seemed to have been gathered ripe, I

therefore took many seeds of these figs to dissect them; and after I had cut or broke their hard husk, I brought out their kernel or pith perfect; and after taking off their film, and had separated the stuff wherein the young plant was laid, I saw the perfect plant, consisting of two leaves, and of that part that is to make the roots and stem.

When eating some strawberries, and fixing my eyes on the little apices we see on a strawberry, I concluded that every one of them was a seed; and to confirm my opinion I took a strawberry, one of the largest and ripest, and there I found a great many seeds, after I had taken off the film wherein they were wrapt up, and found that every seed had also a string by which they were nourished. I opened several of them, by taking off their hard husk, and saw, that every one of them had the stuff we call a pith: having separated this pith from its ancient film, I took out the plant, which I also caused to be delineated, that we might see how many seeds we send together into our stomach, when we eat but one spoonful of strawberries; for when I divided one of the largest into four equal parts, I found in one of these parts about 50 seeds; according to this, the strawberry contained 200 seeds, and another that was much less I guessed to contain 120. Now if we consider that a young plant of strawberries shoots in a year (for I never heard that they sow strawberries) into several shoots over the ground, which take root, and grow all up into plants, and bear the next year; and that besides this, each plant produces many strawberries, each whereof has as many seeds as is before said; we must lay our hand on our mouth, and be astonished at the increasing and great multiplicity of seeds of this plant.

On the Use of Opium among the Turks. By Dr. EDWARD SMYTH, *F.R.S.*

I MADE enquiry for the most famous opium-eater in the country about Smyrna, and had recommended to me one Mustapha Shatoor, an inhabitant of Sediqui, a village six miles from that city, by trade a coffee-man, and 45 years old, when I discoursed with him. He told me his constant eating was three drams a day of crude opium, one half of which was his dose in the morning, and the other half in the afternoon, but that he could safely take double this quantity.

Resolving, therefore, to be an eye-witness of what he could do, I provided the best opium I could get, and weighed it nicely into drams; I desired him to come to me before he

had taken any part of his dose, and that I would entertain him the next morning; he took the invitation thankfully, and came to me the next day at nine in the morning, but excused his having taken half a dram before, because he wanted strength to rise out of his bed without it. I laid before him my opium made up in pills, each weighing a dram, and desired him to eat what he pleased; he took one dram and a half, making it up in three pills, and chewing it with a little water; he commended the opium, but was not willing to eat more at that time, and I would not press him, for fear of accidents. He stayed with me about half an hour after he had eaten the opium; the visible effects it had upon him were to make his eyes sparkle, and to give a new air of life and brightness to his face. He told me that he was extremely refreshed, and made very cheerful by my entertainment, and that it gave him his keph, as the Turks express it.

He went from me to his coffee-house, and being desirous to observe him that day, I found him in half an hour labouring heartily at cleaving wood to burn. I desired his company again, when he was prepared for a second dose; he came to me at three in the afternoon, and took the same quantity as in the morning, and appeared after it with the same symptoms. He told me he would be again ready for the same quantity, at the same distance of time, but I pursued the experiment no further. He says it has always the same effects, giving him vigour and spirit, and is now become as necessary to him, as any other part of his sustenance; that he has many wives and children; that it never affects him with sleep and drowsiness, but rather hinders his reposing, when he happens to take too much of it; that he entered upon this practice 25 years ago, beginning with the quantity of a grain, and so training up nature gradually to larger quantities; that the want of it, and the desire of taking more, grows daily upon him; that his common expence for living is three parahs a day in opium, one in tobacco, two in coffee, and two in bread; a parah is about a penny farthing in our money.

The alteration and impairment which this custom has produced in him are weakness, his legs being small, his gums eaten away, so that the teeth stand bare to the roots, his complexion very yellow, and appearing older by 20 years than he really is. I asked him if he knew any body who could take opium in larger quantities; his answer was, he believed there were none in that country that could outdo him, but that he was informed of some in Arabia, and about

Damascus, where this custom of eating opium obtained more universally.

Opium is commonly taken by the messengers in Turkey, who are employed in taking quick despatches: it is generally part of their provision: they take it when they find themselves tired, and it gives them strength and spirits to proceed. The Turks use opium, made up with something that renders it palatable, at their feast called Biram, to make them cheerful, which may be one reason of its prevailing so much; for finding it then entertains them with pleasing fancies, they are tempted to continue it, and so the use of it becomes necessary and grows upon them.

An Account of strange Beans frequently cast on Shore on the Orkney Isles. By Hans Sloane.

I had several times heard of strange beans frequently thrown up by the sea on the islands, on the north-west parts of Scotland, especially on those most exposed to the waves of the great ocean; they are no otherwise regarded than as they serve to make snuff-boxes. Four sorts of them have been sent me, very fresh, being little injured by the sea: three of these beans grow in Jamaica, where I have gathered them.

How these several beans should come to the Scotch isles, and one of them to Ireland, seems very hard to determine. It is very easy to conceive, that, growing in the woods in Jamaica, they may either fall from the trees into the rivers, or be any other way conveyed by them into the sea. It is likewise easy to believe, that being got to sea, and floating in it in the neighbourhood of that island, they may be carried from thence by the wind and current, which being obstructed by the main continent of America, is forced through the Gulf of Florida, or canal of Bahama, going there constantly E. and into the N. American sea. But how they should come the rest of their way I cannot tell, unless it be thought reasonable, that as ships when they go south expect a trade-easterly-wind, so when they come north, they expect and generally find a westerly wind, for at least two parts of three of the whole year; so that the beans being brought north by the current from the Gulf of Florida, they may be supposed by this means at last to arrive in Scotland.

By the same means that these beans come to Scotland, it is reasonable to believe, that the winds and currents brought from America those several things towards the Azores and Porto Santo, which are recorded by Fernand. Columb. in

the life of his father Christopher, to be some of the reasons which moved the said Christopher Columbus to attempt the discovery of the West Indies. The things mentioned by them are, 1st. A piece of wood ingeniously wrought, but not with iron, taken up by Martin Vicenzo, a Portuguese pilot, 450 leagues at sea, off Cape St Vincent, after a west wind of many days. 2dly. Another piece of wood. like the former, taken up by Pietro Correa, on the island of Porto Santo, after the like winds. 3dly. Very large canes, much beyond any growing in those parts. 4thly. Some of the inhabitants of the Azores observed, and told him, that west winds brought pines to these islands, especially Fayal and Graciosa, which are not found growing in those parts; and that on another of those islands, viz. Flores, was cast on shore two men's bodies, with larger faces, and different aspects, from Christians; and that at Capo della Verga were once seen two canoes or barks with cabins, which were believed to be forced to sea, when accidentally they had been going from one island to another.

On the Structure of the Internal Parts of Fish. By Dr. Charles Preston.

The principal difference between fish and other animals is their want of lungs and respiration; whereas all other animals have lungs, both terrestrial, volant, and amphibious; and in insects, the several tracheæ, that are spread throughout the whole body, serve them instead of lungs. And yet it is necessary that something should supply this in fishes, which may have the same effect on their blood, as the air has upon ours, by entering into our lungs. viz. to divide and dissolve it, and render it fit for circulation. Now we find no part in fish more proper to produce this effect than the bronchia, that lie like so many leaves over each other under their gills; for they receive the water in by the mouth, and return it by the gills; or receiving it in by the gills, they throw it out by the mouth.

It is agreed upon by all, that the water contains something that produces this effect; and this seems most probably to be the air contained in the water, that dissolves the blood in the bronchia of fish, as well as it does that in the lungs of all other animals. That there is air in all water, cannot be doubted, after the experiment of M. Marolle. He set a vessel of water over the fire, so as to drive out the air from it: this water he put into the air-pump, to extract the air from it; and after that filled a phial with it, within two or

three fingers of the top, which space he left only full of air, and stopped the phial well; and by shaking it, the water imbibed the air, so as to rise up and quite fill the phial.

It may be objected, that if the air in the water were the cause of this effect, the fish would live in the open air. I shall only reply to this, that fish have their blood less hot than ours, so that the natural heat of our blood would in them be a fever and mortal; hence we need not wonder they cannot live in the air; for the nitre of the pure air is in too great a quantity, and too subtle, so as it dissolves their blood too much, and makes it too fluid; whereas the nitre in the water is more gross, and in less proportion; whence it gives their blood only a fluidity requisite to keep it in its natural state. To prove that it is in the bronchia that this division is performed, we need only observe their extraordinary redness above any other part of the body, a proof that the blood is there more divided: fish are also found to die in water frozen over, which happens plainly from their communication with the external air being hindered by the ice.

The heart of a fish is different from that of other animals in its having only one ventricle; for it has only the vena cava and the aorta that open into it, having no lungs; so that by the aorta the blood comes out of the heart, which is branched into a thousand capillaries over the bronchia, and is afterwards re-united; which re-union is made under the basis of the cranium; and because the blood, when once there, has no need of being forced higher upwards, they have no occasion for a second ventricle for that purpose, as terrestrial animals have. The re-union of these capillaries of the bronchia being made, they form two large trunks, of which one proceeds towards the head, and the other towards the lower parts.

Fish have a diaphragm, but not for the same purpose as in other animals that breathe; it is always straight and tense, and perpendicular on the vertebræ. Their stomach is membranous: for fish swallow down other small fish whole, and sometimes earth; therefore it is necessary to have a power of contracting itself forcibly to break in pieces its contents. Their intestines make several great windings, a sign the fermentation is but slow in them, which is made up by their great length.

Fish have on the vertebræ of the loins a bladder, very large in proportion to their bulk, which serves, by dilating or compressing itself, to render the fish lighter or heavier, as occasion requires, for swimming. And if this be by any means burst, so that it cannot be extended, the fish can no more

raise itself in the water, but keeps continually at the bottom. The fins and tail assist them in their passage through the water: but it is this dilatation of the air in the bladder that makes them capable of swimming, after the same manner as the dilating of the lungs and thorax of a man bears him up in the water. Flat fish, such as soles, have none of this bladder, for they are able, by reason of their breadth, to sustain themselves in the water. Craw fish and other shell-fish want it likewise, for the most part, for they creep only at the bottom of the water, but there are many fish that have them double.

The Theory of the Tides, extracted from Mr. Isaac Newton's Treatise, entitled, Philosophiæ Naturalis Principia Mathematica. By Mr. EDMUND HALLEY.

THE sole principle on which this author (Mr. Newton) proceeds to explain most of the great and surprising appearances of nature, is no other than that of gravity, by which all bodies in the earth have a tendency towards its centre. From this principle, as a necessary consequence, follows the spherical figure of the earth and sea, and of all the other celestial bodies; and though the tenacity and firmness of the solid parts support the inequalities of the land above the level, yet the fluids, pressing equally, and easily yielding to each other, soon restore the equilibrium, if disturbed, and maintain the exact figure of the globe.

Now this force, of the descent of bodies towards the centre, is not in all places alike, but is still less and less, as the distance of the centre increases, and in this book it is demonstrated, that this force decreases as the square of the distance increases, that is, the weight of bodies and the force of their fall is less, in parts more removed from the centre, in the proportion of the squares of the distance. Thus a ton weight on the surface of the earth, if it were raised to the height of 4000 miles, which I suppose the semidiameter of the earth, would weigh but $\frac{1}{4}$ of a ton, or 500 weight; if to 12,000 miles, or three semidiameters from the surface, that is four from the centre, it would weigh but $\frac{1}{16}$ part of the weight on the surface, or 100 and $\frac{1}{4}$; so that it would be as easy for the strength of a man at that height to carry a ton weight as here on the surface $1\frac{1}{4}$ cwt. And in the same proportion does the velocities of the fall of bodies decrease; for whereas on the surface of the earth all things fall 16 feet in a second, at one semidiameter above the surface this fall is but four feet, and at three semidiameters, or four from the centre, it

is but $\frac{1}{16}$ of the fall at the surface, or but one foot in a second; and at greater distances, both the weight and fall become very small; yet at all given distances they are still something, though the effect become insensible. At the distance of the moon, which I will suppose 60 semidiameters of the earth, 3600 pounds weigh only one pound, and the fall of bodies is but $\frac{1}{3600}$ of a foot in a second, or 16 feet in a minute; that is, a body so far off would descend in a minute no more than the same at the surface of the earth descends in a second of time.

This law of the decrease of gravity being demonstratively proved, the author enquires into the necessary consequences of this supposition; by which he finds the genuine cause of the several appearances in the theory of the moon and planets, and discovers the hitherto unknown laws of the motion of comets, and of the ebbing and flowing of the sea.

Now, the theory of the motion of the primary planets is here shown to be nothing but the contemplation of the curve lines, which bodies projected with a given velocity, in a given direction, and at the same time drawn towards the sun by its gravitating power, would describe. Or which is the same, that the orbits of the planets are such curve lines as a shot from a gun describes in the air, being thrown according to the direction of the piece, but bent into a crooked line by the supervening tendency towards the earth's centre; and the planets being supposed to be projected with a given force, and attracted towards the sun, after the aforesaid manner, are here proved to describe such figures as answer exactly to all that the industry of this and the last age has observed in the planetary motions. So that it appears, that there is no need of solid orbs and intelligences, as the ancients imagined; nor yet of vortices or whirlpools of the celestial matter, as Descartes supposes; but the whole affair is simply and mechanically performed, on the sole supposition of a gravitation towards the sun.

All the surprising phenomena of the flux and reflux of the sea are, in like manner, shown to proceed from the same principle. If the earth were alone, that is to say, not affected by the actions of the sun and moon, it is not to be doubted but the ocean, being equally pressed by the force of gravity towards the centre, would continue in a perfect stagnation, always at the same height, without ever ebbing or flowing; but it being here demonstrated, that the sun and moon have a like principle of gravitation towards their centres, and that the earth is within the activity of their attractions, it will

plainly follow, that the equality of the pressure of gravity towards the centre will thereby be disturbed; and though the smallness of these forces, in respect of the gravitation towards the earth's centre, renders them altogether imperceptible by any experiments we can devise, yet the ocean, being fluid, and yielding to the least force, by its rising shows where it is less pressed, and where it is more pressed by its sinking. Now if we suppose the force of the moon's attraction to decrease, as the square of the distance from its centre increases, as in the earth and other celestial bodies, we shall find that where the moon is perpendicularly either above or below the horizon, in zenith or nadir, there the force of gravity is most of all diminished, and, consequently, that there the ocean must necessarily swell by the coming in of the water from those parts where the pressure is greatest, viz. in those places where the moon is near the horizon. This rightly understood, it plainly follows, that the sea, which otherwise would be spherical, by the pressure of the moon must form itself into a spheroidal or oval figure, whose longest diameter is where the moon is vertical, and shortest where she is in the horizon; and that the moon shifting her position as she turns round the earth once a day, this oval of water shifts with her, occasioning thereby the two floods and ebbs observable in each 25 hours.

And this may suffice as to the general cause of the tides. It remains now to show how naturally this motion accounts for all the particulars that have been observed about them; so that there can be no room left to doubt but that this is the true cause of them. The spring-tides at the new and full moons, and neap-tides at the quarters, are occasioned by the attractive force of the sun in the new and full, conspiring with the attraction of the moon, and producing a tide by their united forces: whereas in the quarters, the sun raises the water where the moon depresses it, and the contrary; so as the tides are made only by the difference of their attractions. That the force of the sun is no greater in this case, proceeds from the very small proportion the semidiameter of the earth bears to the vast distance of the sun.

It is also observed that, cæteris paribus, the equinoctial spring-tides in March and September, or near them, are the highest, and the neap-tides the lowest; which proceeds from the greater agitation of the waters when the fluid spheroid revolves about a greater circle of the earth than when it turns about in a smaller circle; it being plain, that if the moon were constituted in the pole, and stood there, that the

spheroid would have a fixed position, and that it would be always high water under the poles, and low water every where under the equinoctial; and, therefore, the nearer the moon approaches to the poles, the less is the agitation of the ocean, which is the greatest of all, when the moon is in the equinoctial, or farthest distant from the poles. Whence the sun and moon, being either conjoined or opposite in the equinoctial, produce the greatest spring-tides; and the subsequent neap-tides, being produced by the tropical moon in the quarters, are always the least tides; whereas in June and December, the spring-tides are made by the tropical sun and moon, and therefore less vigorous; and the neap-tides by the equinoctial moon, which therefore are the stronger: hence it happens, that the difference between the spring and neap tides in these months is much less considerable than in March and September. And the reason why the very highest spring-tides are found to be rather before the vernal, and after the autumnal equinox, viz. in February and October, than precisely upon them, is, because the sun is nearer the earth in the winter months, and so comes to have a greater effect in producing the tides.

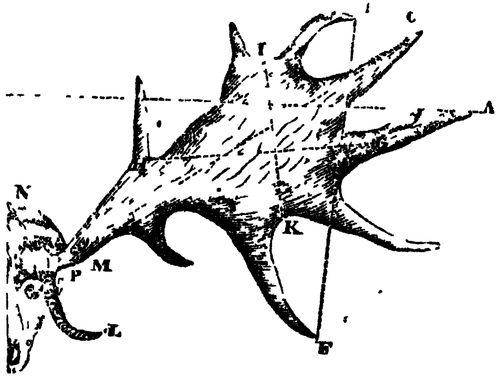
A Discourse concerning the Large Horns frequently found under Ground in Ireland. By THOMAS MOLYNEUX, *M.D.*

BY the remains we have of this animal, it appears to have been of the genus cervinum or deer kind, and of that sort that carries broad or palmed horns, bearing a greater affinity with the buck or fallow deer, than with the stag or red deer, that has horns round and branched without a palm: this I lately observed, having an opportunity of particularly examining a complete head, with both its horns entirely perfect, not long since dug up, given to my brother William Molyneux, as a natural curiosity.

"I have by the bearer sent the head and horns I promised you: this is the third head I have found by casual trenching in my orchard: they were all dug up within the compass of an acre of land, and lay about four or five feet under ground, in a sort of boggy soil. The first pitch was of earth, the next two or three of turf, and then followed a sort of white marl, where they were found."

I took their dimensions carefully as follows: from the extreme tip of the right horn to that of the left, expressed in the line A B, was 10 feet 10 inches; from the tip of the right horn to the root where it was fastened to the head, C D, five

feet two inches; from the tip of the highest branch, measuring one of the horns transverse, or directly across the palm,



to the tip of the lowest branch, E F, three feet seven inches and a half. The length of one of the palms, within the branches, G H, two feet six inches: the breadth of the same palm, still within the branches, I K, one foot 10½ inches: the branches that shot forth round the edge of each palm were nine in number, besides the brow-antlers, of which the right antler, D L, was a foot and two inches in length, the other was much shorter: the beam of each horn at some distance from the head, where it is marked M, was about two inches and six tenths of an inch in diameter, or about eight inches in circumference; at the root, where it was fastened to the head, about 11 inches in circumference. The length N O of the head, from the back of the skull to the tip of the nose, or rather the extremity of the upper jaw-bone, two feet, the breadth of the skull P Q, where largest, was a foot.

Another such head, with both the horns entire, was found some years since buried 10 feet under ground in a sort of marl. And in the year 1691, Major Folliot told me, that digging for marl near the town of Ballymackward, not far from Ballyshannon, in the county of Fermanagh, he found buried, 10 feet under plain solid ground, a pair of this sort of horns, which he keeps still in his possession. In the year 1681, two of these heads were dug up near Turvy, within eight miles of Dublin. Not long since, a head of this kind, with its horns, was found near Portumny, the house of the Earl of Clanricard, seated on the river Shannon, in the county of Gallway. And to my knowledge, within less than 20 years,

above 20, I might safely say 30, pair of such horns have been dug up in several places of this country, all found by accident; and we may well suppose vast numbers still remain undiscovered; so that, doubtless, this creature was formerly common in Ireland, and an indigenous animal, not peculiar to any territory or province, but universally met with in all parts of the kingdom.

That these heads should be constantly found buried in a sort of marl seems to intimate, that marl was a soil that had been formerly the outward surface of the earth, but in process of time, being covered by degrees with many layers of adventitious earth, it has, by lying under ground a certain number of ages, acquired a peculiar texture, consistence, richness, or maturity, that gives it the name of marl; for we must needs allow that the place where these heads are now found, was certainly once the external superficies of the ground; otherwise it is hardly possible to conceive how they should come there. And that they should be so deep buried, as we at present find them, appears to have happened by their accidentally falling where it was soft low ground: so that the horns, by their own considerable gravity, might easily make a bed, where they settled in the yielding earth; and in a very long course of time, the higher lands being by degrees dissolved by repeated rains, and washed and brought down by floods, covered those places that were situated lower with many layers of earth: for all high grounds and hills, unless they consist of rock, by this means naturally lose a little every year of their height; and sometimes sensibly become lower even in one age.

On Fossil Wood dug up at Youle, in Yorkshire. By RICHARD RICHARDSON, *M. D.*

AT Youle, about 12 miles below York, near the place where the Dun runs into the Humber, there are several persons, called tryers, who, with a long piece of iron, search in the soft and boggy ground for subterraneous trees; and by this means they can in a great measure discover the length and thickness of these trees, and get a livelihood by it. Some are so large, that they are used for timber in building houses, which is said to be more durable than oak itself; others are split into laths; others again are cut into long splinters, and tied up in bundles, and sent to the market towns, several miles off, to light tobacco. These trees, when found, are all broken off from the roots; I suppose by violence of storms or

water, or both The tryers affirm, that at three or four yards depth they find stumps of trees broken off; some two, three, or four feet from the ground, which are of exactly the same wood with the subterraneous trees. The bate or texture of this wood is the same with fir, splitting easily; when burnt, it emits the same resinous smell, and it affords the same coal. The branches generally grow in circles, as appears by the knots, which easily part from the rest of the wood, as is usual in fir-wood. The straightness and length of these trees lead also to a presumption, that they must be such; if one considers that some of these are near 100 feet long; and at the bottom, not much above a foot in diameter. It is affirmed, that their tops lie all one way, viz with the current of the water. Oaks are also found there, though not in so great quantity. The vitriolic parts of the earth, in which they have lain, has given them a black tincture, quite through, which, when wrought and polished fine, is but little inferior to ebony: this does not emit the same smell when burnt, with that called fir-wood; so that the smell of that wood cannot be attributed to the bituminous parts of the earth in which it has lain. About 60 or 70 years ago, several Dutchmen undertook to drain a large marsh in that place; and in cutting a channel in the dry ground between the fen and the river, at first they threw up a rich and firm soil, afterwards they met with a stratum of sand, under that a stratum of boggy ground, in which they found some of these subterraneous trees, and under that firm ground again. The place, where these trees are found, is a long flat, on the one side bounded by the raging river Humber, which often breaks its banks.

The Torricellian Experiment tried on the Top of Snowdon-hill. By Mr. Hallay.

Wednesday, May 26. I was on the top of Snowdon, where I tried the Torricellian experiment with all the satisfaction I could wish for: the air continued, both before and after, in the same state, as I got it verified by Mr. Davis's standing barometer at Llanerch in Denbyshire, about 25 miles east from Snowdon, where it was observed, during four days, to stand from 29.7½ to 29.8½ inches.

May 26., between one and two in the afternoon, on the top of Snowdon, I thrice repeated the experiment, and as often found the height of the mercury 26.1 inches. And being come down to Llanberris, at the foot of the hill, about six that evening, I as often found it 29.4 inches. A little above

this place are the principal fountains of the river that falls into the channel of Anglesey, at Carnarvon, called anciently Segontium, whither we went the next day; and about eight at evening, found the mercury, by a triple experiment, to stand at 29.9 inches, very near the surface of the sea: when, at the same time, at Llanerch, it was not above 29.7½; whence I conclude, that the difference of the air's pressure on the sea and on the top of Snowdon is rather more than three inches eight tenths.

Account of a moving Bog in Ireland.

JUNE 7. 1697, near Charleville, in the county of Limerick, in Ireland, a great rumbling or faint noise was heard in the earth, much like the sound of thunder nearly spent. For a little time the air was somewhat troubled with little whisking winds, seeming to meet contrary ways: and soon after that, to the greater terror of a great number of spectators, a more wonderful thing happened; for in a bog the earth began to move; viz. meadow and pasture land that lay on the side of the bog, and separated by an extraordinary large ditch; and other land on the further side adjoining to it; and a rising, or little hill, in the middle of the bog, hereupon sunk flat. This motion began about seven o'clock in the evening, fluctuating in its motion like waves, the pasture land rising very high, so that it overran the ground beneath it, and moved upon its surface, rolling on with great pushing violence, till it had covered the meadow; upon which it remains 16 feet deep. In the motion of this earth, it drew after it the body of the bog, part of it lying on the place where the pasture land, that moved out of its place, had before stood; leaving great breaches behind it.

The quantity of this bog is about 40 acres. Adjoining to it is a piece of firm pasture land, of 4½ acres; and adjoining to this, a piece of meadow land, of 3½ acres. The meadow was lower by a descent of five feet than the pasture, and the pasture was lower by six feet than the surface of the bog; and there was yet a considerable rising and hill near the middle of the bog, the height of which was ten feet above the surface of the bog; so that there was a descent from it to the meadow. A more than ordinary wet spring occasioned a prodigious swelling of the height of the bog at the said elevation, and at length moistened the whole, but chiefly its under part, the water soaking to the bottom. By this means the turfy hill being undermined, naturally sunk down, and

consequently pressed the bog on all sides, till the pasture was forced on the meadow, overturning the intermediate hedge.

Description of an Opossum, dissected at Gresham College. By EDWARD TYSON, *M. D.*

THIS animal, which was brought alive from Virginia, has several names given it by different authors. But since it is an animal sui generis, and in several parts has a great resemblance to those of different species, I think a denomination might be best given to it, from that particular in which it is most distinguished from all others; which is that remarkable pouch, or marsupium, it has in the belly; into which, on any occasion of danger, it can receive its young As to its dimensions, from the extremity of the nose to the tip of the tail, it measured 31 inches; the length of the head, six inches; the tail, one foot long; the compass of the body, 15½ inches; when alive and well, it seemed much thicker: the fore-legs were six inches long; the hinder-legs but 4½ inches. The fore-feet have five long claws or fingers, equally ranging with one another, and a hooked nail at the end of each finger; but the hinder-legs are formed differently, having but four fingers armed with hooked nails, and a perfect thumb set off at a distance from the range of the other fingers. This thumb had not a hooked or curved prominent nail, but a tender flat one, as in a human body. This contrivance of the legs, feet, and the nails, seems very advantageous to this animal in climbing up trees, which it does very nimbly in quest of birds, a prey it is very fond of, though it also feeds on other things.

At the bottom of the belly, in the middle, between the two hinder-legs is observed a slit or aperture, moderately extended about two inches long: but capable of a larger extension, by dilating it with the fingers, even when alive. The animal can so exactly close and contract it, that the eye does not readily discover it. There is, on each side of this aperture, a reduplication of the skin inwards, forming a hairy bag; but the hairs are so thinly set, that almost every where the skin is seen through them. The use of this bag, pouch, or marsupium, is to preserve the young, and secure them on any occasion of danger; and the contrivance is admirable in forming and adapting this part so suitably to that end. For there are two remarkably strong bones, not to be met in any skeleton, of great use.

These bones are so fastened to the upper and inner edge

of the ossa pubis, that at their basis here they touch each other, just at the coalition of the bones that form the ossa pubis. The other extremities of these bones were at a distance from one another, that measured 2½ inches. The basis of these bones where joined to the ossa pubis was half an inch broad, having two heads; the larger lying near the coalition of the ossa pubis, and the lesser towards the os coxendicis; having in the middle a sinus, into which was received a protuberance of the ossa pubis; by which contrivance it appears there can be no motion of these bones, nearer or farther from one another, but that they must stand always at an equal distance; but they were capable of a small motion inwards towards the spine, and outwards from it These bones, as they ascended from the os pubis, grew slender, being about the middle but a quarter of an inch broad; and they were each two inches long. These bones were furnished with four pair of muscles; and another pair ran over them, to which they performed the office of a trochlea, or pulley. The first pair of muscles (*i. e.* which first came to be dissected, on the pronation of the animal, and from its figure I call triangularis,) arise fleshy from the whole length of the internal side of these bones, and insert their opposite tendons on each side of the rima, or aperture of the marsupium. Under part of the muscles lay another, or a second pair, flat and thin, having their origin from the upper part of the internal side of the ossa marsupialia, and inserting their opposite tendons a little above the tendons of the former muscles: the tendency or direction of the muscular fibres of this pair, in respect of the first, made a decussation. The third pair of muscles had their rise from the fore-part of the basis of these bones, where they were joined to the os pubis; and were afterwards inserted into the linera aspera of the thigh-bone. The fourth pair arose from the external side of these bones near the basis, and are inserted into the fore-part of the thigh-bone near the middle. The last pair of muscles arises more immediately from the marsupium or pouch itself; for spreading their muscular fibres all over this bag, as they issue from it, by joining their fibres together, they more remarkably form a solid muscle; which passing on each side over the middle of these bones, *i. e.* in the prone posture of dissecting the animal, they at length were inserted into the spine of the os ileum.

By considering the structure of these muscles, and what must be the effect of their action or contraction, one cannot but think the first two must serve towards the dilatation or

opening the marsupium or pouch: for these bones are a fulciment or basis, their articulation not admitting of a contraction inwards, or nearer to each other; wherefore, when the first and second pair of muscles act, or contract, they must necessarily open or dilate the mouth of the marsupium or pouch. The third and fourth pair may serve to extend these bones outwards; so that when this animal hangs by its tail, as it frequently does, the weight of the fœtus in this pouch by this means will not press so much on the internal viscera. The fifth and last pair, as they may serve to dilate the capacity of the pouch itself, so likewise may serve the better to suspend its weight, when the animal is prono capite, and if it gravitates too much, they may retract it upwards, and this the easier, as passing over these bones like a pulley, their force is more augmented. The antagonist to these muscles is the sphincter marsupii, an oval series of strong fleshy fibres, which serve to constringe and close the orifice of the pouch; which it does so perfectly, that one would think the skin here not to be slit; nor can the orifice be observed till it is dilated with the fingers.

The pouch, or marsupium itself, was a membranous body, not very thick, though consisting of several coats, and is reducible to the class of the vesicular parts of the body; which seem to be partly muscles, partly glands, and to perform the office of both motion and secretion: for the cavity of this pouch was somewhat hairy, and at several places I could observe them matted together by a yellowish substance, which oozed out of the cutaneous glands. This liquor discharged into the pouch from the glandulous coat was strong scented, and had more of the peculiar fœtor of this animal than any part besides. But after the skin, with the pouch, had been kept for some days, and was grown dry, there was so great an alteration in the smell, that what before was so disagreeable, was now become a perfect perfume, and smelled altogether like musk; though the general consent of all authors had branded it with the note of a fœtid stinking animal. But the same is to be observed in the richest perfumes we have, as musk, civet, and ambergris.

This marsupium had likewise a muscular coat, besides the several other muscles bestowed on it, to give it motion. It had also a vascular coat, being plentifully irrigated by blood vessels, especially by two large branches, that came from the upper part of the thorax, and might be reckoned the mammaria, as they are styled in other animals. This pouch was fastened by several membranes to the muscles of the abdomen

and the skin, but so as to be easily separated, for the most part, with my fingers.

In this marsupium, or pouch, many writers on the natural history of this animal place the mammæ or teats; and they tell very odd stories about it: I will only relate what they say of it, and what I at present observed, or rather did not observe. I did not find any teats here, nor even on the outward skin, as is usual in other multiparous animals. Possibly this subject never had a litter; and for want of drawing, the teats might be less, so as to escape notice. The male also, if we may believe Piso, has such another purse under his belly, and takes his turn to carry the young, in order to ease the female. This contrivance of nature for securing the young from any danger, till they are able to shift for themselves, is perhaps not to be paralleled in any other species of animals, at least of the quadruped kind.

The first two vertebræ of the tail had only one small acute spine; but in all the other vertebræ of the tail, both at the head and tail of each vertebra, there were two spines; but those at the head of the joint the larger. In the first six vertebræ of the tail there was on each side a broad transverse process, the length of the joint; in the other vertebræ, only at the head and tail a jetting out at the sides. The vertebræ about the middle of the tail were the longest; being there about an inch long; nearer the root of the tail, and at the end, not so long.

But there is a wonderful piece of nature's mechanism in those spines or hooks, placed in a line in the middle of the under side of the vertebræ of the tail. It is true the first three vertebræ had none of these spines, nor were they necessary here, since they lay within the compass of the ossa coxendicis; but in all the other vertebræ, to the end of the tail, they were to be observed; and as they approached the extremity of the tail, they grew less and shorter. These spines, where longest, were about one fourth of an inch, or somewhat more: they were placed just at the articulation of each joint, and in the middle from the sides, and seemed to be articulated, both to the preceding and following vertebra; not being an entire solid bone, but rising from the vertebræ with crura or legs, become afterwards perfectly united at the ends. By this means, these bones are rendered more firm and strong, and this hollow serves for transmitting the blood-vessels through them; and one may here observe a stria or furrow, all the length of the vertebræ, for receiving them; by which they are the better secured from compres-

sion, when the animal hangs by its tail; and for performing this office, nothing could be more advantageously contrived: for when the tail is twisted or wound about a stick, this hook of the spine easily sustains the weight, and there is but little labour of the muscles required, only sufficient for bending the tail; for then, as by a hook, the weight of the whole body is here suspended. And for performing this, it was observed, that in each preceding vertebra, there arose a muscle, which was inserted on each side of the succeeding vertebra; which acting or contracting, must necessarily bend and curve that joint. But for the strengthening the whole, there was observed four muscles to arise from the os sacrum, which ran the whole length of the tail; two on the upper side, and two on the under; sending each a tendon to each internode or vertebra. So that when the skin was stripped off, the external parts of these muscles seemed to have tendinous expansions over them, the whole length of the tail, and to be almost covered by them; which must needs very much contribute to add strength to the tail; besides what may be the effect of their insertion of tendons into each joint or vertebra, in curling and unbending the tail.

Fig. 1. represents the outward shape and figure of the

Fig. 1.

opossum, drawn from the life. Fig. 2. the slit or aperture in the belly, opening to the marsupium or pouch, where the young ones lodge, till they can shift for themselves. Fig. 3. *a*, the marsupium turned inside outward, where may be observed the hair or fur that covers it,

Fig. 3.

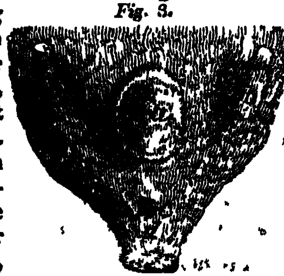
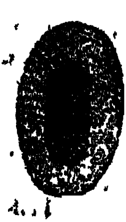


Fig. 2.



which may help to keep the young ones warm; *b b* the two hinder legs cut off; *c* the foramen of the anus, which is also the common outward vent or exit to the rectum, the bladder of urine, and the uteri also; *d* the beginning of the tail.

Concerning the Eyes of Beetles, &c. By Mr. Anthony Van Leuwenhoek.

I have formerly spoken of the multiplicity of eyes, wherewith the smaller sort of insects are endued, as flies are; which eyes I have several times shown to different persons, to their great satisfaction; and that in such a manner, that they could clearly discern the appearance of some hundreds of eyes at once. Among the rest, I have last summer shown to several English gentlemen the multiplicity of eyes that are to be seen in the tunica cornea of a beetle, called the eye. I cut that part of a beetle which is reckoned to be his eye from the head, and after I had made it clean, fixed it before the magnifying glass, and observed, that it could not make up half the bulk of a globe, it being broader than it was long. I however counted, to the best of my power, the eyes that were in one row, in the greatest semicircle, and found that there were at least 60. Now let us suppose, that in the small semicircle of the tunica cornea there are but 40 eyes in one row, and then add these 60 to the 40, and it makes 100, the half whereof is 50, which I imagine, if we take the tunica cornea for half a globe, they stand in the greater half circuit of the same. Whence Mr. L. computes that 3181 is the number of these eyes that are in both the tunicæ corneæ of a beetle; if they both make up a whole sphere

Account of one Edmund Melloon, who was of an extraordinary Size.

The measures of some of the parts of this Irishman, 19 years of age, shown at Oxford, were communicated by Dr. Plot. He was seven feet six inches high; his finger 6¾ inches long, the length of his span 14 inches, of his cubit two feet two inches, of his arm three feet 2½ inches, from the shoulder to the crown of his head 11¾ inches.

Of the Posture-master, or a Man having an absolute Command of his Joints and Muscles.

In Pall-Mall, London, lived one Clerk, called the Posture-

master, who had such an absolute command of all his muscles and joints, that he could disjoint almost his whole body; so that he imposed on the famous Mullens, who looked on him in so miserable a condition, that he would not undertake his cure; though he was a well-grown fellow, yet he would appear in all the deformities that can be imagined, as hunch-backed pot-bellied, sharp-breasted; he disjointed his arms, shoulders, legs, and thighs, that he appeared as great an object of pity as can be: and he has often imposed on the same company, where he has been just before, to give him money as a cripple; looking so much unlike himself that they could not know him. I have seen him make his hips stand out a considerable way from his loins, and so high that they seemed to invade the place of his back, in which posture he had so large a belly, that though one of our company had one of a considerable size, yet it seemed lank compared with his; he turned his face into all shapes, so that by himself he acted all the uncouth, demure, odd faces of a Quaker's meeting: I could not have conceived it possible to have done what he did, unless I had seen it; and I am sensible how short of a full description I have given of him. He began young to bring his body to it; and there are several instances of persons that can move several of their bones out of their joints, using themselves to it from childhood.

The Symptoms that attended the Bite of a Serpent.

MR. ROBERT BURDETT, an English merchant at Aleppo, was bit by a serpent on the left wrist, near the pulse towards his hand: it seemed at first like two pricks of a pin: he immediately vomited, and his wrist and hand began to swell presently; he had some few days before a looseness, which this, perhaps, increased: he rode easily alone, after he was bit, above two miles off to Aleppo, he felt no pain, but a great desire to sleep; his arm continued swelling upwards, and grew black. Some remedies were used, till the rest of the factory returned, who then began to cup and scarify his arm; he having still no pain, but a great drowsiness. At last the swelling came up to his shoulder, and then he complained much; and within one quarter of an hour he died. He was bit about ten in the forenoon, and died about three in the afternoon. His body swelled much after death, and purged.

The snake was in length like a common snake; his colour dark sandy, with black spots; his two teeth, or fangs, like

those of a rattle-snake, on the upper jaw. The poison lies in the gums: and wherever they fetch blood of any creature they certainly kill; though in some parts sooner than in others. The oil of tobacco kills the serpent, if put in his mouth, as was experienced. The people of the country say, that if, as soon as any one is bit by a serpent, they shall suck immediately the wound, they may be saved; but they rub first their gums and teeth with oil, that none of the poison may touch any place where the skin is broken, and spit out immediately what they suck; every time washing the mouth, and taking more oil.

This serpent killed a dog, in about eight minutes' time, biting him at the end of his ear; and two young turkeys afterwards in three or four minutes each, biting them at the root of a claw; and then we poisoned him with the oil of tobacco out of a reed-pipe, (that had been much used, and not cleansed for a week or two,) and he died in about two or three minutes, trembling as soon as the oil was dropped into his mouth. There are people who get their bread by showing these serpents: they find them in hot days near rocks, and putting a forked stick near the head, they take them up carefully by the neck, and put them into a leather bag.

On the Scarabæus Galeatus Pulsator, or the Death-Watch. *By Mr.* Benjamin Allen.

This animal makes a noise resembling a watch: it lived four days with me, beating exactly. I found it in a copper: it resembled dry dirt in colour. I found another some years before on a rotten post, and it made the noise like a watch, by beating its head on the subject that it finds fit for sound. This was answered by another in the same room, and after a minute's distinct beating, it would forbear for the other to answer. The part it beats with is the extreme edge of the face, which I may call the upper lip, the mouth being protected by this bony part, and lying underneath, out of view.

It was five sixteenths of an inch long; the colour a dark brown, with spots somewhat lighter, irregularly placed, which would not rub off readily. They lie athwart on the back, and direct on the head. Under the vaginæ are pellucid wings, and the body is of a dark colour. The head appeared large, by reason of a large cap or helmet which covered it round, only turned up a little at the ear: from under this appeared

the head, which was flat and thin; the eyes forwards: the lip hard and shining; the bars of the helmet greyish.

On an Eruption of Fire out of a Spot in the Earth. By Dr. Robert St. Clair

I lately received an account from my brother, that on the side of one of the Appenine mountains, half way between Bologna and Florence, near a place called Petra Mala, about five miles from Fierenzola, there is a spot of ground, about three or four miles diameter, which incessantly sends up a flame rising very high, without noise, smoke, or smell, yet it gives a very great heat, and it has been observed to be always thus, except at great rains, which put it out for a time, but when that is over, it burns with greater vigour and heat than before; the sand about it, when turned up, sends up a flame; but within three or four yards of it there grows corn all round about, for it continues always in the same spot. The flame seems to proceed from a vein of bitumen or naphtha, that cropes, as the miners call it, only here; which, when by ploughing or some other accident the upper crust has been turned up, was kindled into a flame by the heat and agitation of the air, as other salino-sulphureous bodies are. The inhabitants there have been so little curious to observe it, that they believed that there was a great hole in the flame-place, but he found it to be firm ground. Neither does any there remember, when, and upon what occasion, it first began. The flaming well near Wigan seems to proceed from a similar cause: you may boil an egg in it, and upon the approaching of a lighted candle it takes fire: both seem to proceed from a naphtha or subtle bitumen, only that in a hotter country, and being in a drier soil, is more subtle and inflammable.

Captain Longford's Observations on his own Experience upon Hurricanes, and their Prognostics.

It has been the custom of the English and French inhabitants of the Caribee islands to send, about the month of June, to the native Caribees of Dominico and St. Vincent, to know whether there would be any hurricanes that year; and about 10 or 12 days before the hurricane came, they would constantly send them word; and it very rarely was erroneous, as I have observed in five hurricanes, in the years 1657, 1658, 1660, 1665, and 1667. From one of these Indians, I had the following prognostics:—

1. All hurricanes come either on the day of the full, change, or quarters of the moon. 2. If it be to happen on the full moon, observe these signs during the change: the skies will be turbulent, the sun redder than usual, a great calm, and the hills clear of clouds or fogs over them, which in the high lands are seldom so; likewise in hollows, or concaves of the earth, or wells, there will be a great noise, as of a storm, and at night the stars will look very large with burs about them, and the north-west sky very black and foul, the sea smelling stronger than at other times: and sometimes for an hour or two of that day the wind blows very hard westerly out of its usual course. On the full of the moon you have the same signs, with a great bur about the moon, and frequently about the sun. The same signs must be observed on the quarter days of the moon, in July, August, and September, the months when the hurricanes are most prevalent. The earliest I ever heard of was the 25th of July, and the latest the 8th of September; but the usual month is August.

The causes of these hurricanes, according to experimental observations of my time, are these:—

1. It is known to men of experience, that to the southward of the tropics there is constantly a trade-wind, or easterly wind, which goes from the north to the south-east all the year round; except were there are reversions of breezes, and inlets near the land; so that when this hurricane, or rather whirlwind, comes in opposition to the constant trade-wind, then it pours down with such violence as exceeds any storms of wind. In the hurricane at Nevis, I saw the high mountain that was covered with trees left in most places bare.

2. It is remarked by all men, that have been in those parts where the sun comes to the zenith, that at his approach towards it, there is always fair weather; but at his return southwards, it occasions, off the north parts of the equinoctial, generally much rain and storms, as tornadoes, and the like; which makes the wind in the tornado come on several points. But before it comes, it calms the constant easterly winds; and when they are past, the easterly wind gathers force again, and then the weather clears up fair.

3. The wind being generally between the tropics and the equator easterly, unless at such times as before mentioned; meeting with the opposition of these hurricanes, which come in a contrary course to that trade-wind, causes this violent whirlwind, on the sun's leaving the zenith of Barbadoes, and these adjacent islands; by which the easterly wind loses

much of its strength; and then the west wind, which is kept back by the power of the sun, with the greater violence and force pours down on those parts where it gets vent. And it is usual in sailing from Barbadoes, or those islands to the north, for a westerly wind, when we begin to lose our easterly wind, to have it calm, as it is before hurricanes: and then the wind springing up, till it comes to be well settled, causes the weather to be various; but after the settled westerly wind comes fresh, they have been constantly without those shufflings from point to point.

Here it is to be observed, that all hurricanes begin from the north to the westward, and on those points that the easterly wind blows most violently, the hurricane blows most fiercely against it; for from the N. N. E. to the E S. E. the easterly blows freshest; so does the W. N. W. to the S. S. W. in the hurricane blow most violent; and when it comes back to the S. E., which is the common course of the trade-wind, then it ceases of its violence, and so breaks up. Thus I take the cause of hurricanes to be the sun's leaving the zenith of those parts towards the south; and, secondly, the reverse or rebounding back of the wind, which is occasioned by the calming of the trade-wind.

Some Experiments and Observations concerning Sounds. By Mr. Walker.

Intending to try the swiftness of sounds, I provided a pendulum, which had two vibrations in 1″ of time: this I carefully adjusted at a watchmaker's: it was a piece of small virginal wire, with a pistol bullet at its end; the length was $9\frac{6}{10}$ inches to the middle of the bullet: I first made it about $\frac{1}{10}$ of an inch longer, viz. one fourth of the length of a pendulum that vibrates seconds, but found it too slow, which I expected from the air's resistance.

Here follow the numbers, in English feet, which sound moved in one second of time at several trials:—

Trials.	Feet.	Trials.	Feet.	Trials.	Feet.
1	1256	5	1292	9	1278
2	1507	6	1378	10	1290
3	1526	7	1292	11	1200
4	1150	8	1185		

Mersenne mentions an experiment, in which he found the motion of sound to be 1174 feet in a second. And the

Academy del Cimento caused six harquebusses and six chambers to be fired, one after another, at the distance of 5739 English feet, and from the flash to the arrival of each report was 5″: and repeating the experiment at the mid-way, the motion was exactly in half the time, which gives 1148 feet per second. Mr. Boyle also mentions that he has more than once diligently observed, that the motion of sound passes above 400 yards, or 1200 feet in 1″.

Mersenne and the Academy del Cimento conclude, that sounds are all of the same quickness, whether they be great or small, and whatever temper the air is of, though Mersenne was once of another mind: but Kircher, from several experiments, infers, that loud sounds move quicker than small ones. Dr. Plot says, an echo returned the sound of a pistol much quicker than that of the voice; and that it repeated more syllables in the night than in the day; whence it follows that the sound moved slower in the night than in the day. Kircher says, that an echo, which in the night repeated 14 syllables, repeated only seven in the day. Because there seems to be so great affinity between the undulations of water and the propagation of sound, the Academy del Cimento tried some experiments about the first; and they tell us, that the larger the stone is, which is thrown into the water, and the greater the force, by so much is the undulation swifter.

On the Generation of Fleas. By Sig. D. Cestone.

Fleas bring forth eggs, or a sort of nits, from which are hatched worms; these make bags like silk-worms, and from these bags come fleas. They deposit their eggs on dogs, cats, men, and other animals infested with them, or in places where they sleep, which being round and smooth, slip commonly down to the ground, or fix themselves in the folds or other inequalities of the coverlets and clothes. From these are brought forth white worms, of a shining pearl colour, which feed on the branlike substance which sticks in the combs when puppies are combed to take out the fleas; or on a certain downy substance that is found in the folds of linen, or other similar things.

In a fortnight's time they are very lively and active: if they have any fear, or be touched, they suddenly roll themselves up, and become as it were a ball. A little after they creep as silk-worms do that have no legs, with a brisk and swift motion. When they are come to their usual size, they hide themselves as much as they can, and bringing out of

their mouths the silk, they make round themselves a small bag, white within as paper, but without always dirty and fouled with dust. In two weeks more, in the summer-time, the flea is perfectly formed; then it soon leaves its exuviæ in its bag, as silk-worms and all caterpillars do; which leave in the same their exuviæ. The flea, so long as it is enclosed

Fig. 1.

Fig. 2.

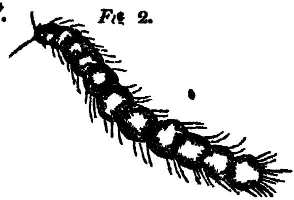
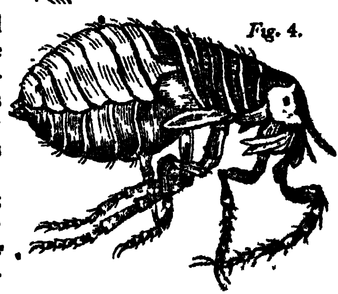


Fig. 3.

Fig. 4.



in the bag, is milk-white, and has legs; but two days before it comes out, it becomes coloured, grows hard, and gets strength; so that coming speedily out, it straight leaps away.

Fig. 1. represents the eggs; fig. 2. the worm; fig. 3. the bag; and fig. 4. the flea; but all magnified by the microscope.

On Sable Mice, which have lately come in Troops into Lapland, about Thorne, and other Places adjacent to the Mountains. By Sir PAUL RYCAUT, *F.R.S.*

IN the year 1697 these sable mice were first observed, and are nearly as large as a small squirrel: their skin streaked, and spotted black and light brown; they have two very pointed teeth above, and two below; their feet like those of squirrels: they are so fierce and angry, that if a stick be held out at them they will bite it, and hold it so fast, that they may be swung about in the air: they are fat and thick, and without any tail.

In their march they keep a direct line, generally from north-east to south-west, and are innumerable, thousands in each troop, which for the most part is of a square figure: they march by night and in the twilight, and lie still by day. The distance of the lines they go in is of some ells, all parallel to each other, so that the places they have gone over look

like the furrows in a ploughed field. If they meet any thing that might stop them, they avoid it not, though it were a fire, a deep well, a torrent, lakes, or morass, but without any hesitation venture through, and by that means many thousands of them are destroyed, and found dead in waters, and otherwise.

If they be met swimming over lakes, and attacked with oars or boat-hooks, they neither retreat, nor offer to run up the oars, &c. but hold on their course, and if forced out of it they presently return to it again. When they are met in woods or fields, and stopped, they set themselves on their hinder feet like a dog, and make a kind of barking or squeaking noise, leaping up as high as a man's knee, defending their line as long as they can; and if at last they be forced out of it, they creep into holes, and set up a cry sounding like biabb, biabb.

They never come into any house, nor meddle with any thing that is food for man: if a house happen to be in their way, there they stop till they die; but through a stack of hay or corn they will eat their way: when they march through a meadow they injure it much by eating the roots of grass; but if they encamp there by day they quite spoil it, and make it look as if it were burnt, or strewed with ashes. The roots of grass, with rotten wood, and the insects in it, are their chief if not only food. These creatures are very fruitful, and bring forth eight or nine at a time; yet this does not hinder their march; for some of them have been observed to carry one young one in their mouth, and another on their back.

It is reported that some poor Laplanders, wanting other food, have killed and ate several of these creatures, and found their flesh like that of squirrels: dogs and cats, when they kill them, eat only the heads, and birds of prey only the heart: during the winter they lie under the snow, and have their breathing holes upon the top of it, as hares and other creatures. The common people are very glad of these guests, as they foretell plenty of game, as fowl, squirrels, lo-cats, foxes, &c.

These mice are the same with those called mures Norwegici, Norway mice, described by Olaus Wormius in his museum, now Lemming's.

On the Cures performed by Mr. Greatrix, the Stroker. By Mr. Thoresby

The first instance I shall mention of his cures was my

brother John D——n, who was seized with a violent pain in his head and back when about 14 years of age. One of my sisters at that time had the small-pox, and my mother, judging that he was taken with the same distemper, used no means to remove it, till by accident Mr. Greatrix coming to our house, and hearing of his illness, desired to see him; he ordered the boy to strip to his shirt, and having given present ease to his head by only stroking it with his hands, he fell to rub his back, which he most complained of, but the pain immediately fled from his hand to his right thigh; he followed it there, it fell to his knee, from thence to his leg, but he still pursued it to his ankle, thence to his foot, and at last to his great toe; as it fell lower it grew more violent, especially when in the toe it made him roar out, but upon rubbing it there it vanished, and the boy cried out, It is quite gone. It never troubled him after, but he took the small-pox about three weeks after. The next instance was Mrs. D——: she was seized when a girl with a great pain and weakness in her knees, which occasioned a white swelling; and having used divers means to no effect, after six or seven years' time Mr. Greatrix coming to Dublin, he was brought to her, where he stroked both her knees, the pain flying downwards from his hand, it drove it out of her toes: he gave her present ease, and the swelling in a short time wore away, and never troubled her after. One Mrs. L——e, who, after a fever, was much troubled with a pain in her ears and very deaf, came to Mr. Greatrix, who put some of his spittle into her ears, and turning his finger in them rubbed and chafed them well, which cured her both of the pain and deafness. Mr. Charles L——n was cured by him of the same malady, having nearly lost his hearing by some accident, till Mr. Greatrix, by stroking, restored it. Mrs. S——n, when a child, was extremely troubled with the King's evil: her mother sent her to be stroked in King Charles the Second's time to London, but she received no benefit; yet Mr. Greatrix perfectly cured her. One Pearson, a smith, had two daughters extremely troubled with the evil, the one in her thigh, the other in her arm: he cured them both.

"I could add many things of this nature, both of what I have seen and heard from my mother, who was much more with him than myself, but wanting room, shall only tell you, that where he stroked for pains, he used nothing but his dry hand: but for ulcers or running sores he used spittle on his hand or finger; and for the evil, if they came to him before it was broke, he stroked it, and ordered them to poultice it with boiled turnips, and so did every day till it grew fit for lancing;

he then lanced it, and with his fingers would squeeze out the cores and corruption, and then in a few days it would be well, with his only stroking it every morning. Thus he cured many who continue well to this day; but if it were broke before he saw them, he only squeezed out the core, and healed it by stroking. Such as were troubled with fits of the mother, he would presently take off the fit, by only laying his glove on their head, but never cured the distemper thoroughly, for the fits would return. I have heard he cured many of the falling sickness, if they stayed with him, so that he might see them in three or four fits; otherwise he could not cure them.

Beds of Oyster-shells found near Reading, in Berkshire. By Dr. James Brewer.

These shells have the entire figure and matter of oyster-shells, and, doubtless, are such. The compass of the ground where they are dug up is near six acres. Just above the layer of these oysters there is a greenish earth, or rather sand, and under them chalk. I have often seen in several chalk-pits a few scattered oyster-shells. But in this place, they are, as it were, one continued body, and in an even line, through the whole extent of the ground.

This stratum of green sand and oyster shells is about two feet thick. Immediately above this layer of green sand and shells is a bed of a bluish sort of clay, very hard, brittle, and rugged, called a pinny clay, and is near three feet thick; and immediately above it is a stratum of fuller's earth, which is near 2½ feet deep, often used by the clothiers; and above this earth again is a bed of a clear, fine, white sand, without the least mixture of any earth, clay, &c., which is near seven feet deep; then immediately above this is a stiff red clay, being the uppermost stratum, of which tiles are made. The depth of this cannot be conveniently taken, it being so high a hill, on the top of which is dug a little common earth, about two feet deep, and immediately under appears this red clay. I dug out several whole oysters, with both their valves or shells lying together, as oysters opened before. These shells are so very brittle, that in digging, one of the valves will frequently drop from its fellow; but it is plainly to be seen that they were united together, by placing the shell that drops off to its fellow-valve, which exactly corresponds. I dug out several that were entire, nay, some double oysters with all their valves united.

An Account of Giants. By Dr. Thomas Molyneux.

The os frontis in the anatomical school at Leyden, though it be so vastly large, cannot in the least be suspected to have appertained to any other animal than a man, being complete every way, and answering in all particulars to the common forehead-bone of other men, excepting its magnitude. And arguing from the proportion that the same bone in other men bears to their height, it must follow that the man to whom this os frontis belonged was more than twice the height that men usually are, according to the common course of nature. And setting down, as the most moderate computation, but 5½ feet for the height of a man, he to whom this bone belonged must have been more than 11 or 12 feet high.

There is a manifest alliance and congruity observable in nature, between the stature of a man's body and his age during the time of his growth; and as 5½ feet may well be esteemed the most settled and ordinary degree of height in a man, so about 70 years may justly be allowed the most common period of his age: we have daily instances of exceptions; Thomas Parr and Henry Jenkins, both of England, and the old Countess of Desmond and Mrs. Eckleston, both of Ireland, who fully completed double the usual term of life; so we have no reason to question the accounts given us of others, that have been found in stature double the common standard of man. Nay, both longevity and high stature naturally so result from their proper causes, that they are often observed to become hereditary, and run in whole families; whence the Greeks had their Macrobii, and the Romans their Celsi; and in Palestine, of old, they had their Anakims, or sons of the giants. So that human gigantic bodies are nowise inconsistent with the course of nature. And, indeed, we have testimonies from authors of unquestionable credit, that there have been men in the world, and it is likely there still are, of such stature, as properly to deserve the name of giants.

The first I shall mention was one I saw and measured at Dublin, in the year 1682, his name Edmond Malone, who measured seven feet seven inches. Walter Parsons, porter to King James the First, born in Staffordshire, was nearly of the same stature; and I find several other men born in England who have arrived to this height.

Isbrand Diemerbroeck, in his Anatomy, tells us, that he saw at Utrecht, in 1665, a man 8½ feet high, all his limbs well shaped, and his strength proportionable to his height: he was born at Schoonhoven, in Holland, of parents of an ordinary

stature. Mr. Ray, in his Travels, mentions having seen this man at Bruges, in Flanders. Johannes Goropius Becanus, who lived in Flanders, has recorded several instances still more remarkable: he says he saw a youth almost nine feet high, a man near 10 feet, and a woman quite 10 feet in height. Pliny the naturalist particularises by name several men in his own age much of the same height as those mentioned by Becanus.

To these histories we may add the many concurring testimonies given us by various travellers of gigantic men seen in their voyages in the more remote parts of the world. Andreas Thevet, in his Description of America, tells us, that he was shown by a Spanish merchant the skull and bones of an American giant, who was 11 feet five inches in height, and died in the year 1559: he showed them to M. Thevet, who took the measures of the principal of them; the bones of the legs measured three feet four inches in length, and the skull was three feet one inch about. Which circumference is exactly proportionable to the length of the legs; and if we make an allowance for the hair and skin that covered the skull when he was alive, it falls very little short of the dimensions we have before set down, in computing the size of our giant's head when it was entire.

From these warrantable histories, and this particular bone before us, we may clearly deduce that there have been human bodies 11 or 12 feet high; equal to the stature of the tallest giants mentioned in holy writ. For the height of Goliath of Gath is expressly said to be but six cubits and a span; and taking a cubit in the most usual acceptance for a foot and a half, his stature will not amount to above nine feet nine inches. Indeed we may reasonably conclude, that Og the King of Bashan must have considerably exceeded Goliath in height, if we make an estimate of his stature by the dimensions of his bedstead, which is said to have been kept as a memorial of him at Rabbath of the children of Ammon, and to have been nine cubits in length; but then we cannot imagine but that his bed must of necessity have been much longer than his body; and the least allowance we can make for the overplus is the space of nine inches above his head, and as much below his feet; and if we make this deduction, it will follow he was not above 12 feet high; much of the same standard with this giant, whose forehead-bone is still kept in the medical school at Leyden.

On the Fossil Shells and Fishes at Broughton, in Lincolnshire. By the Rev. Mr. Abr. de la Pryme.

In this parish are two stone pits, or quarries, very remarkable. The first is at the east end of the town, the other in the field, on the south of the town. The stones of the first are not much used for building, being soft, but what they dig them chiefly for, is to get a clayey substance, or earth, that lies under them, to cement and lay the stones of the second quarry in, of which they build their walls and fences. In which earth are innumerable fragments of the shells of shell-fish of various sorts, of pectinites, echini, conchites, and others, with some bits and pieces of coral. And here are sometimes found whole shell-fish, with their natural shells on, in their natural colours, much bruised and broken, and some squeezed flat by the great weight of the earth.

The other quarry is in the field on the south side of the town. It is a hard blue stone, in the stones of most of which are innumerable petrified shell-fish of various sorts, but so united to the stone, that it is very difficult to get them out whole; and I have always found that they lie in the superficies of the quarry within a foot of the top, and few or none deeper. In many places of the surface of the quarry, (which looks rugged and drifted, as snow does after a storm,) there are many shell-fish, half in the stone and half out; just as we see in rivers and ponds that are dry, they will lie half within the mud, half without. That part which is within the quarry is entire and whole, but a hard stone, and that part which is without, which the petrific effluvia did not touch, is consumed and gone, all but a little of the edges, which edges are plain shell, and have all the radii and striæ on them that the shells of those sorts of fishes commonly have.

All these shell-fish have their shells on: some of which are comparatively thin. Sometimes the shells are in their petrifaction so thoroughly united unto and incorporated with the stone, that they are scarcely visible. Others in the same quarry have a thick white shell on them petrified, but not incorporated with the substance of the bed in which they lie. In getting the fish out, all the shell sticks so fast to the rock, that most commonly it is left behind; but sometimes the shell cleaves in two, one half of the shell on both sides of the fish sticks to it, and the other half to both sides of the bed, but others come out by lying in the air in frosty nights, with the whole natural shell on, and the radii or striæ very exact. There are other fish here, that have a black smooth shell,

with several striæ, but no radii, very like, if not the same with the concha nigra Rondeletii.

I have also seen in this quarry some shell-fish half open, and filled with the matter of the bed in which they lie, and petrified with it. Others being in heaps together, I have found some of them broken, some bruised, and the edges of one fish thrust into the sides of another, some with the one shell thrust half way over the other, &c. and so petrified in the bed together. Others in the same bed have been so close, that the matter of the bed could not insinuate itself into them. Some of these that are thus found are quite empty, others are filled with crystalline fluors; others I have seen half full of the bluish clay of the bed, and half full of the said crystallisations, which proceeded from nothing but subterraneous heat and effluvia.

Among the fish in this quarry, I have seen several large horse-muscles, such as breed in fresh-water rivers and ponds, which are exactly like the concha longa Rondeletii, but are thicker and fuller than they commonly are; which largeness proceeds from the fertility and fatness of the bed where they breed; and in an old pond beyond Broughton Hall, there are some of the largest sort of this shell-fish that ever I saw; as if this soil agreed better to the breeding of this sort of fish than any other.

As some thrive in a rich clayey soil, so other sorts of shell-fish love a stony gravelly soil, others a chalky soil, others a rocky soil, others a lime-stone or salt soil; others, again, love an oozy soil, a sort of a confused mixture of all the foregoing, as part of the country about Frodingham, Brumbee, Ashbee, Botsworth, &c. In the fields and stones of which towns is one particular sort of fish, which I know not what genus or species to compare to, bending somewhat like a ram's horn, and exactly creased on the outside like one, with an operculum or lid on it, which the fish opened and shut as it had occasion. The bed whereon the said shell-fish bred is not above a foot thick, in which, but for the most part in the superficies, are millions of the said fish sticking half in the stone and half out, which having a most durable shell, that part which sticks out of the stone is not consumed, as in the shell-fish of Broughton, but remains whole and entire. Yet I have seen whole lumps of them, that by some great weight fallen upon them have been shattered in pieces, and so petrified in the bed as they lay.

In the parish of Broughton also, in the loose earth above the blue quarry, and elsewhere, I have found, in a whitish

stone, the echini galeati puncticulati Lluydii, the turbinites major Lluydii, the coclites lævis vulgatior Lluydii, in blue stone, the concha altera longa Rondeletii, exactly agreeing to the draught and size of it in Gesner de Piscibus. I have found also multitudes of belemnites, great and small, perforated and flat at the root, by which they grew in the antediluvian sea, to some of which were found sticking little shell-fish.

From all this it sufficiently appears, that there was a time when the water overflowed this country.

And hence it happens that we find shells and shell-fish, and the bones of other fishes and quadrupeds, and fruits, &c. petrified and lodged in stone, rocks, mountains, quarries, and pits; for it was then the proper place for them to breed in, and upon, and to be found in at this time. And as all countries were thus raised out of the bottom of the sea and lakes, so that part of the country about Broughton appears manifestly to have been the bottom of some fresh-water lake, because those are fresh-water shell-fish that are found there, and the bed on which they breed was a fine blue clay, which is the colour of the stone to this day. Which bed, by the power of the subterraneous steams and effluvia, was turned by degrees into stone with all the fishes therein.

I have also a hard stone, part of the same blue quarry, with little bits of wood-coal in it, and whole leaves of vaccinia, or whortle-berries, such as grow on heath; and Mr. Llwyd and the Miscel. Cur. in Germany, have given several large accounts of whole leaves and plants found in stones and rocks, and deep in the bowels of the earth, some folded, some plain, some imperfect, all of which is very easily solvable, by their being in that general hurry and confusion seized upon, and embodied in lumps of clay and other matter, while others were caught and intercepted in rolling beds of earth, as they tumbled down from rising hills and mountains, and so were lodged deep in chasms of the ground, and petrified.

Observations on the Fossils of Reculver Cliff. By Mr. Stephen Gray.

I was extremely satisfied with the account which Mr. De la Pryme gave of his observations on the shells in the quarries near Broughton. To the many instances the earth exhibits of the great and violent mutations she has suffered, be pleased to take a remarkable one of those I have observed in Kent. About half a mile from Reculver, towards Herne,

there appears in the cliff a stratum of shells in a greenish sand: they seem to be firm, and some of them are entire; but when you attempt to take them from their beds, they crumble to powder between your fingers: the shells are of the white conchites. But what is most remarkable is, that in the lower part of the stratum, where the shells lie thickest, there are scattered up and down portions of trunks, roots, and branches of trees. The wood is become as black as coal, and so rotten, that large pieces of it are easily broken with the fingers. I know not at what depth these may lie, the surface of the stratum not appearing above two feet from the beach, but I judge it from the superficies or top of the cliff about twelve feet. The stump of one tree standing upright was broken off about a foot from the ground.

Letter from Dr. Wallis to Dr. Tyson, concerning Man's feeding on Flesh.

Gassendus in one of his epistles states, as his opinion, that it is not originally natural for man to feed on flesh; though by long usage, at least ever since the flood, we have been accustomed to it, and it is now become familiar to us; but rather on plants, roots, fruits, grain, &c. God says to Adam, "I have given you every herb bearing seed, and every tree in the which is the fruit of a tree yielding seed, to you it shall be for meat;" but without any intimation of his feeding on the flesh of animals. But, without disputing it as a point in divinity, whether men before the flood did or might feed on flesh, supposing it to be wholesome nourishment, the Doctor considers it, with Gassendus, as a question in natural philosophy, whether it be proper food for man.

The consideration insisted on by Gassendus is from the structure of the teeth, being mostly either incisores or molares; not such as in carnivorous animals, are proper to tear flesh, except only four, which are called canini; as if nature had rather furnished our teeth for cutting herbs, roots, &c. and for bruising grain, nuts, and other hard fruits, than for tearing flesh, as carnivorous animals do with their claws and sharp teeth. And even when we feed on flesh it is not without a preparative coction, by boiling, roasting, baking, &c. And even so we forbid it to persons in a fever, or other like distempers, as of too hard digestion. And children, before their palates are vitiated by custom, are more fond of fruits than of flesh-meat. And their breeding worms is wont to be imputed to their too early feeding on flesh.

This ingenious conjecture of Gassendus presently suggested to the Doctor another speculation, which seems not less considerable, viz. There is in swine, sheep, oxen, and in most quadrupeds that feed on herbs or plants, a long colon, with a cæcum at the upper end of it, or somewhat equivalent, which conveys the food by a long and large progress from the stomach downwards, in order to a slower passage and longer stay in the intestines; but in dogs of several kinds, and probably in foxes, wolves, and divers other animals which are carnivorous, such colon is wanting; and, instead of it, is a more short and slender gut, and a quicker passage through the intestines.

What the Doctor would propose hereupon is, to consider whether it generally holds, or how far, that animals which are not carnivorous have such a colon, or somewhat equivalent, and that those which are carnivorous have it not. For if so, it seems to be a great indication that nature, which may be reasonably presumed to adapt the intestines to the different sorts of aliments that are to pass through them, accordingly informs us to what animals flesh is proper aliment, and to what it is not; and that from thence we may judge more solidly than from the structure of the teeth only, whether or not flesh was designed as proper food for man.

Now it is well known, that in man, and probably in the ape, monkey, baboon, &c. such colon is very remarkable. It is true, that the cæcum in man is very small, and seems to be of little or no use: but in a fœtus it is in proportion much larger than in adults; and it is possible that our customary change of diet, as we grow up, from what originally would be more natural, may occasion its shrinking into this contracted posture.

On an Insect commonly called the Death-Watch. By the Rev Mr. WILLIAM DERHAM.

OF these death-watches, or insects which make a noise like the beats of a watch, I have observed two sorts. This year I caught many of them; two of which, a male and female, I kept alive in a little box about three weeks; and could make one of them beat whenever I pleased, by imitating his beating. At last one died, and the other gnawed its way out through the side of the box.

The other death-watch is in appearance quite different from the last: it beats only about seven or eight strokes at a time, and quicker; but this will beat some hours together without

intermission, and his strokes are slower, and like the beats of a watch. I have several years observed these two sorts of beating, but took it to be made by one and the same animal. The insect which makes this long beating is a small greyish animal, much resembling a louse, when looked on with the naked eye; for which reason I call it pediculus pulsatorius It is very nimble in running to seek its shelter when disturbed. It is very common in all parts of the house in the summer months. They are extremely shy of beating when disturbed; but will answer you when you beat, if you do not disturb them · I cannot tell whether they beat in any other thing, but I have heard their noise only in or near paper.

Concerning their noise, I am somewhat in doubt, whether it be made by beating their heads or rather snouts against the paper; or whether it be not made after some such manner as grashoppers and crickets make their noise.* I rather incline to the former opinion. But my reason for doubting is, because I have observed the animal's body give a sudden jerk at every stroke, but I could scarcely perceive any part of it touch the paper. It is possible it might beat the paper, and I not perceive it, as its body is small, and near the paper when it beats, and its motion in beating is sudden and swift: for which reasons also it is hard to perceive the insect to beat without a very quick eye; and therefore I made use of a convex-glass, which by magnifying gave me much better opportunity of observing it.

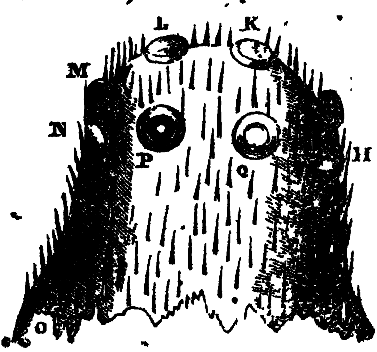
Concerning Spiders, their Way of killing their Prey, spinning their Webs, &c. By M. Leuwenhoek.

About the latter end of February, I caught a black spider, and viewing it with my microscopes, I observed that his body and legs were covered with a great number of hairs, that stood as thick as the bristles on a hog's back. Though hairy, yet the legs were so clear, that I could easily perceive the circulation of the blood in several veins which were not a hair's breadth distance from each other; and afterwards I saw other fine blood-vessels, that were not the tenth part of a hair's breadth distant from each other.

I have often seen a spider hanging down from a branch of a tree by a thread of his own making, and holding fast by one of his hind-legs, which has three particular claws, two of which are at the very end, and each claw is armed with several teeth like saws, which towards the joining with the foot grow narrower and closer together, and where the thread

it has spun may be close twisted, just as in a pully, on which the clockmakers put their lines to fasten the weight on, which in the beginning is wide and large, but the longer it grows the narrower it is

The fig. ABCDEF represents a small part of the leg of a spider; BCD show the two extreme claws, armed with teeth like saws; E the third that has no teeth; which claw I suppose he uses on several accounts; this is certain, that when the spider does not wind himself by his thread upwards, but runs along his web, then he takes hold of the spun thread with this third claw. The above-mentioned spider is provided with eight long and two short legs; which last stand out on each side of the head, having such claws as are before mentioned. Further, I discovered eight distinct eyes, two of which are on the top of the head, in order to see what passes above him Below those were two other eyes, to look straight forwards. On each side of the head were two more, close to each other; the two foremost eyes to see, I suppose, what passed collaterally before him, the two hindmost to see the same backwards.



The engraving shows the fore part of the body separated from the membrane or pellicle it lay in; PQ the eyes that look upwards; KL those that look straight forwards; IM those that look sideways forward; HN those sideways backward. Now as the spider's eyes are immoveable, having no muscles belonging to them, it is easy to conceive how necessary eight eyes are, in order to look round about, the more easily to catch his prey.

I found that the spider has two instruments or cases for his sting, in the fore-part of his head, which, when he does not use, he places in great order under his eyes, and between his two short legs. These stings are crooked like a claw, and very much resemble the stings of scorpions, or Indian

millepedes. The stings of a spider have towards the end, and on each side, a little hole, from whence, according to all appearance, when he strikes his enemy, he ejects a liquid matter, which we call poison.

When I put two or three of the largest sort of spiders together in the glass, I observed that when they met, they never parted without an engagement, in which one has been sometimes wounded in such a manner, that his body was wet with the blood spilt in the battle, and that he died soon after. I always observed that the lesser fled from the greater; and when it happened that two of an equal size met together, neither retired, but held one another so fast by their stings, that one would remain dead without once stirring, and as wet with the blood it had lost, as if it had lain some-time in the water. I had one spider that was wounded by his antagonist in the thickest part of his leg, from whence issued one drop of blood as large as a sand grain; not being able to use this wounded leg in running away from his enemy, he raised it up on end, and presently after the whole limb fell off from his body; and I have observed, that when they are wounded in the breast, or upper part of their bodies, they always die.

When I formerly opened or dissected a spider, in order to discover that viscous matter, which I took to be the beginning of their web, and not finding it, I was amazed, being unable to conceive how such a strong thread could in so short a time proceed out of such a moist body, strong enough to bear the weight not of one only, but even six spiders; and when I endeavoured to find out the manner how they make their webs; one and the same thread seemed to me sometimes to consist of a single thread, and sometimes of four or five; but I could never see how the threads issued from the spider's body. Since then, I took a spider, and laid it on its back, so that it could not stir, and with a very fine pair of pincers drew out a thread, which I could perceive sticking out of one of the working instruments; in doing which I saw abundance of very fine threads coming out of the body at the same time; which, as soon as they were one or two hair's breadth distant from the body, were joined together, and so made thick threads.

Now, as we may perceive that a spider's web, which to our naked eye seems but single, yet consists of many other threads, and thus acquires a greater strength; we may from hence certainly conclude, that no flexible bodies (excepting metals, whose parts are strongly cemented by the force of fire,) can attain to any degree of strength, unless they consist

of long united parts; and the more these are twisted together, or cemented with any viscous matter, the stronger they are; which is very obvious in flax, or silken thread, ropes, &c.

To endeavour to discover the internal machinery of these curious threads, I proceeded to the dissection of the body of one of the largest spiders I could get, and very curiously investigated each part of it; and, at last, to my great amazement, I discovered the vast number of instruments from whence each single thread proceeded; indeed the number was so great, that I judged them to be at least 400: yet they did not lie close by one another, but were divided into eight distinct parts or instruments; so that if the spider set all these eight instruments to work at once, there would proceed from the same eight particular threads, which were again subdivided into a great number of smaller; but one of the great threads would be thicker than the other, because one part of the body would produce twice as many threads as the other just by it.

I once took a very small frog, the length of whose body was about an inch and a half, and put him into a glass tube, together with a large spider, in order to see how they would behave; when I observed, that the spider passed by the frog without touching him, but yet he had drawn out his stings, as if he intended to have fallen directly upon the frog. Afterwards I caused the frog to run against the spider, who thereupon struck it in the back with its stings, and wounded the frog in two several places, in such a manner, that in one place he left a red speck, and in the other a blue one. Hereupon I brought them together again; when the spider struck his stings into the fore-leg of the frog, who upon that struggled so hard that the spider was forced to leave him; and I observed that some few of the blood-vessels in the frog's legs were wounded. Once again I forced the frog to jostle the spider, who upon that struck both his stings into the frog's nose, after which they both stood still about half a minute: then opening the glass I took the spider out, while the frog sat still about an hour, then stretched out his hinder legs, and died.

I took a spider's eggs, and putting them into a glass tube, carried them about me, to see if they would hatch. They were laid by the largest spider that I had seen the last summer, and it was one of the last I could meet with in the gardens. On the 17th of the same month, in the morning, viewing them again, I saw 25 young spiders that were come

out of so many eggs, and about 25 more whose bodies were but half out of the egg-shell, and some of them had their shells hanging upon their tail; and in the evening, about six o'clock, I reckoned 150 young ones. The next day I viewed them again, and then I concluded that no more spiders would come out of the eggs, and that several which I saw lying about the glass were barren, and that in others the young spiders were dead; the number of which I judged to be about 50; and about 10 or 12 eggs were blackish. When the glass tube, where the young spiders were, had been out of my pocket but 15 minutes, in very cold weather, I could hardly discover any life or motion in some of them; but so soon as the glass tube had been a little warmed again, they were brisk and lively, and most of them got together in a company, as we see in swarms of bees, and so hung about the web, where the eggs had been lodged before.

January 21st, I could perceive the eight eyes in every spider, which before were not so visible: but now being of a brown or darkish colour, they were easily distinguishable from the fore-part of their body, which was white, as the hinder part was yellowish.

January 22d, I observed that the legs of many of the spiders, which before had been clear and transparent, now assumed a dark colour, and afterwards began to be covered with hair; whereas I could perceive none a little before.

On the 23d, their legs grew darker, as also the hinder part of their bodies, whence their web proceeds, and that also began to be covered with hairs; I observed, also, that they had cast their very thin skins, and began to be much nimbler in their motions.

The 25th, I saw them spin a thread, and manage it with their hinder-feet as well as the old ones; I observed, also, that they had eaten up the barren eggs, and the others wherein I supposed the young ones to be dead, which where about 50 in number: for a few days after there remained nothing but the bare shells.

I have compared the threads of a full-grown spider with one of the hairs of my beard; the thickest part of which was placed before the microscope; and according to the nicest observation, I judged that above 100 of those threads laid together did not equal the diameter of one hair; now supposing this hair to be round, then 100 of the fine threads of a spider's web are not thicker than one single hair. Now if we add to this, as it is most certainly true, that 400 young spiders, when they first begin to spin, are not one with

another, larger than one full-grown spider, and that each of those young ones is provided with all the working instruments of the old one, it would follow that the smallest thread of such a young spider is 400 times smaller than that of a large one, and if so, then 4,000,000 threads of a young spider are not so large as a hair; but then again, if we consider of how many parts one of those smallest threads consist, we stand astonished at the thought.

January 30th, most of them were employed in weaving their web, so that the glass swarmed with them. February 8th, I could perceive that many of the spiders had eaten each other up; and at the very time I looked on them, there were four upon one, whom they had almost devoured; and here and there I saw pieces of legs; and now the shells of the barren eggs were eaten up so clear, that I could see nothing of them remaining.

February 10th, my spiders were reduced to half their number, and those that remained were eating the thickest of their companions' legs. Thus they diminished daily, so that on the last of the said month I could see but 30 of them alive, among which a few were 20 times as large as some that remained. March 5th, I could see but three or four alive, and about the web I observed a black matter, about which the spiders had swarmed very much, and I found that it was nothing else but a heap of legs of those young spiders, whose bodies had been devoured.

On the whole, in this animal, which to some people is so odious, I have discovered as much perfection and hidden beauties as in any other; for when I took the fleshy muscles out of their legs, and viewed them through the microscope, I was astonished at their transparency, and they seemed to be one body; but when I came to separate them, I found that they were composed of very long particles, each consisting of so many folds or wrinkles, that the muscle might be dilated or contracted, as occasion should require.

Concerning Trees found under Ground in Hatfield Chase. By the Rev. Mr. Abraham de la Pryme.

The famous levels of Hatfield Chase, in Yorkshire, were the largest chase of red deer that King Charles the First had in all England: containing in all above 180,000 acres of land, about half of which was yearly drowned by vast quantities of water. This being sold to one Sir Cornelius Vermuiden, a Dutchman, he at length effectually dischased, drained, and

reduced it to constant arable and pasture-grounds, and at the immense labour and expense of above 400,000*l*. In the soil of all, or most of the said 180,000 acres of land, of which 90,000 were drained, even in the bottom of the river Ouse, and in the bottom of the adventitious soil of all Marshland, and round about by the skirts of the Lincolnshire Woulds unto Gainsburg, Bautry, Doncaster, Baln, Snaith, and Holden, are found vast multitudes of the roots and trunks of trees of all sizes, great and small, and of most of the sorts that this island either formerly did, or that at present it does produce; as firs, oaks, birch, beech, yew, thorn, willow, ash, &c. the roots of all or most of which stand in the soil in their natural position, as thick as ever they could grow, as the trunks of most of them lie by their proper roots.

Most of the large trees lie along about a yard from their roots, (to which they evidently belonged, both by their situation and the sameness of the wood,) with their tops commonly north-east; though indeed the smaller trees lie almost every way, across the former, some over, and others under them; a third part of all being pitch-trees, or firs, some of which are 30 yards in length and upwards, and sold for masts and keels for ships. Oaks have been found of 20, 30, and 35 yards long, yet wanting many yards at the small end; some of which have been sold for 4*l*., 8*l*., 10*l*., and 15*l*. a piece; they are as black as ebony, and very durable in any service they are put to. As for the ashes, it is commonly observed, that the constituent parts of their texture are so dissolved, that they become as soft as earth, and are commonly cut in pieces by the workmen's spades, which, as soon as flung up into the open air, crumble into dust; but all the rest, even the willows themselves, which are softer than ash, preserve their substance and texture entire to this day. I have seen some fir-trees that, having lain horizontally, after they fell, have shot up large branches from their sides, which have grown up to the bulk and height of considerable trees.

It is evident, that many of those trees have been burnt, especially the fir-trees, some quite through, and some on one side; some have been found chopped and squared, some bored through, others half split with large wooden wedges and stones in them, and broken axe-heads, somewhat like sacrificing axes in shape: and all this in such places, and at such depths, as could never have been exposed since the destruction of this forest, till the time of the drainage. Near a large root, in the parish of Hatfield, was found eight or nine

coins of some of the Roman emperors, much consumed and defaced by time; and it is very observable, that on the confines of this low country, between Burningham and Brumby in Lincolnshire, are several great hills of loose sand, under which, as they are yearly worn and blown away, are discovered many roots of large firs, with the marks of the axe as fresh upon them as if they had been cut down only a few weeks; as I have often with pleasure seen.

Hazel-nuts and acorns have frequently been found at the bottom of the soil of those levels and moors, and whole bushels of fir-tree apples or cones, in large quantities together; and at the very bottom of a new river or drain (almost 100 yards wide, and four or five miles long,) were found old trees squared and cut, rails, stoops, bars, old links of chains, horse-heads, an old axe, somewhat like a battle-axe, two or three coins of the Emperor Vespasian, one of which I have seen in the hands of Mr. Cornelius Lee of Hatfield, with the Emperor's head on one side, and a spread-eagle on the other: but what is more remarkable is, that the very ground at the bottom of the river was found in some places to lie in ridges and furrows; thereby showing that it had been ploughed and tilled in former days.

My friend, Mr. Edward Canby of this town, told me that about 50 years ago, under a great tree in this parish, was found an old-fashioned knife, with a haft of a very hard black sort of wood, which had a cap of copper or brass on the one end, and a hoop of the same metal on the other end, where the blade went into it. He also found an oak-tree within his moors, 40 yards long, four yards diametrically thick at the great end, three yards and a foot in the middle, and two yards over at the small end; so that, by moderate computation, the tree seems to have been as long again. At another time he found a fir-tree, 36 yards long, besides its computed length, which might well be 15 yards more. So that there has been exceedingly great trees in these levels; and what is also very strange, about 50 years ago, at the very bottom of a turf-pit, there was found a man lying at his length, with his head upon his arm, as in a common posture of sleep, whose skin being tanned, as it were, by the moor-water, preserved his shape entire, but within, his flesh, and most of the bones were consumed.

To illustrate and render more intelligible this strange subject of subterraneous trees, we may here advert a little to what has been observed in other places and countries. Cam-

den and others have told us, and it is a very common and well known thing, that most of the great morasses, mosses, fens, and bogs, in Somersetshire, Cheshire, Lancashire, Westmoreland, Yorkshire, Staffordshire, Lincolnshire, and other counties in England, are full of the roots and trunks of large trees, most of which are pitch or fir, and that they have the same positions and impressions of the fire and axe on them as those above mentioned.

Giraldus Cambrensis tells us, that in King Henry the Second's days, by the force of extraordinary storms, the sands were so much driven off the sea-shore in Pembrokeshire, that under them were discovered great numbers of roots and trunks of trees in their natural positions, with the strokes of the axe as fresh upon them as if they had been cut down only yesterday, with a very black earth, and some blocks like ebony. And the like were discovered also at Neugall, in the same county, in 1590, and in Cardiganshire, and in other places since.

Dr. Plot mentions the like roots and trees, found in Shebben-Pool, the old Pewit-Pool, and at Layton, and other places in Staffordshire; and from their natural situations he rightly concludes, that they certainly grew there.

Dr. Leigh, in his History of Cheshire, observes, that in draining Martin Meer, there was found multitudes of the roots and trunks of large pitch-trees, in their natural positions, with great quantities of their cones, and eight canoes, such as the old Britons sailed in; and in another moor was found a brass kettle, beads of amber, a small mill-stone, the whole head of a hippopotamus, and human bodies entire and uncorrupted, as to outward appearance. Many places, too, of the soil of Anglesea and Man, as also of the bogs of Ireland, are full of roots and trees.

As to other countries, Verstegan tells us, that in many places of the moors and morasses of the Netherlands, large fir-trees are commonly found, with their tops lying to the north-east, just as they do in the levels of Hatfield Chase And Helmont mentions the Peel there, a moss more than nine miles broad. Also M. de la Fer says, that trees and roots are also frequently found in the low grounds, and in the levels and morasses, of France, Switzerland, and Savoy. And, lastly, Rammazzini assures us, that in the territories of Modena, which are several miles long and broad, and at present a most fruitful dry country, though, in the time of the Cæsars it was nothing but a great lake, are found at 30, 40, and 50 feet deep, the soil of a low marshy country, full of

sedge, reeds, shrubs, roots, trees, nuts, ears of corn, leaves of trees, branches, and boughs of oaks, elms, walnuts, ashes, willows, and the very trees themselves, some broken, some whole, some standing upright, some lying at their length, &c. with old coins of the Roman emperors, old marbles and stones squared, cut, carved, and wrought by the hands of men.

M. de la Pryme then proceeds to show that all these forests were cut down or destroyed by the Romans and other military people; but the geology of our days takes different views, and his paper is chiefly valuable for the facts which it has assembled.

Concerning some Remains lately observed in Lincolnshire. By Mr. Thoresby.

Near the river Welland, that runs through the town of Spalding, in Lincolnshire, at the depth of about eight or ten feet, there were found jettys, as they call them, to keep up the old river bank; and the head of a tunnel, that emptied the land-water into the old river; also, at a considerable distance from the present river, I guess 20 or 30 yards, there were dug up, at the like depth, several old boats; all which show, that anciently the river was either much wider than now, or ran in another place, or both. On the north-west side of the river, and more upwards in the town, were dug up, at about the same depth, the remains of old tan vats or pits, a great quantity of ox-horns, shoe-soles, and the very tanners' knobs, &c.; which shows that the surface of the country lay anciently much lower than now, and has been raised by the sea throwing in sand on the maritime parts, which are now mostly inhabited, and by the moor or rotten sedge in the fenny parts next the high country: the whole level is about 50 miles in length, and 30 miles in width in the broadest parts. No record or tradition whatever informs us when these mutations happened.

At the laying of the present new sluice or gout, as they call it, at the end of Hamorebeck, at its fall into Boston haven, on taking up the foundation of the old sluice, they met with the roots of trees, many of them issuing from their several trunks, spread in the ground; which, when they had taken up, and the roots and earth they grew in, they met with a solid gravelly and stony soil, of the high-country kind, but black and discoloured by the change it had suffered; upon which hard earth they laid the foundation of this new sluice; which

was certainly the surface of the old country before it was covered by the sea, and was much deeper than that at Spalding, as the land is there at present higher.

Concerning Green Weeds growing in Water, and some Animalcula found about them. By M. Leuwenhoek.

I have often heard the common people say, that that green stuff or weeds, observed to drive upon the water, spring out of the ground from under the water. But as often as I have observed the said green weeds, I have always found that they are produced from the seeds of the same kind, as all other trees and plants are

I took several of these weeds, and put them into a glass tube of a finger's breadth, filled with water, and also in a lesser tube, and let the roots of the weeds subside leisurely; then viewing them with my microscope, I observed a great many, and different kinds of animalcula, of which two sorts had long tails, by which they seemed to be fastened to the roots of the weeds. These animalcula were shaped like a bell, and they moved the round cavity of their bodies in a manner that they put the small parts of the water into such a motion that I could not see the instruments they used to produce it.

And though I saw 20 of these animalcula together, gently moving their long tails and outstretched bodies, they contracted their bodies and tails in an instant, and then gently extended them again; and this kind of motion they continued a great while.

H I K L M N O P Q R represent a small part of the said root, as it appeared in the microscope, through the whole length of which were to be seen its vessels with their divisions; which roots, I imagine, were of no further use, and in a manner withered; they were also overgrown with a great many particular long particles, and mostly with little figures like flowers, as are represented in the fig. between K and L. The animalcula before mentioned are to be seen like little bells, at I S T and N V W; I saw above a hundred of these animalcula, with their tails fastened to the root, and living, between H I K L M, but other roots had none of them.

In several of these roots I observed one, and some few times two, sheaths or cases fastened in them, of several sizes; the largest is represented by R X Z Y. Out of the same sheath appeared a little animal, the fore-part of whose body

was roundish, as in X Z Y; and presently, from the same rotundity, proceeded two little wheels, that had a swift gyration, always one and the same way, as in *a b c*; these small wheels were as thick set with teeth as the wheel of a watch; and when these animalcula had for some time exerted their circular motion, they drew their wheels into their body, and their body wholly into their sheaths, and then soon after thrust them out again with the aforesaid motion; another while they remained as it were shut up in their shells; and though I observed the same wheels in other animalcula also, yet their bodies differed from each other, and

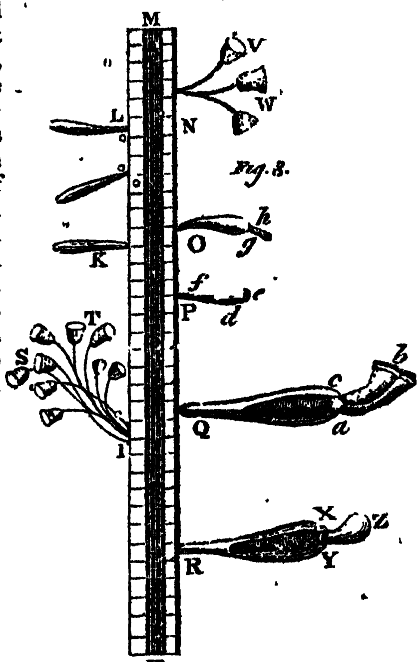
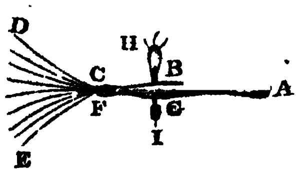


Fig. 8.

their sheaths were of a darkish colour, so that I could not easily perceive the animalcula; and they seemed to be composed of globules.

P *d e f* represent the sheath with the little worm P *d f* in it: in the same figure, O *g h* show a sheath with half the body of the same animalcule *g h* protruded out of it; and in which, by reason of its exceeding smallness, the wheels could only be seen now and then, and that only when the body was extended, which would soon be compressed or shrunk up; and about the middle of the body of one of these, which I conceived to be the lower part of its belly, there was another of the same kind, but smaller, the tail of which seemed to be fastened to the other.



A B C D E F G H represent one of these, about double the

natural size, whilst it was in the water, and fastened to the root of the green weeds; A is the tail with which it fastens itself; C D E represent eight horns (though others that were smaller had but six); it is drawn as stretched out at its whole length; but when contracted, it was not the fourth part so long.

B H show an animalculum coming out of the body of the larger, which phenomenon at first I thought might be a young animalcule fastened by chance to an old one; but observing it more narrowly, I saw it was a partus, for I could now see, that although this animalcule, when I first discovered it, had only four very small horns, 16 hours after it was grown much larger, both in horns and body, and four hours after that, it forsook its mother's belly.

In the discovery of the said young animalcule, I had observed, on the other side of the body of the largest animalcule, a small round knob of seed, which, in a few hours, grew larger, and at last pointed; and in 13 or 14 hours it became so large, that I could see two horns upon it. In 24 hours it had acquired four horns, one of which was small, the second larger, the two others very large; and these two last were more strongly protruded and contracted than the smaller. Three hours after, this animalcule was got clear of its mother.

I endeavoured to pursue my discovery of the generation of these creatures, and in order thereto, wiped off the green weeds from the body, the better to make my observations; when the animalcule was found not only dead, but his horns and part of the body quite wasted.

Another animalcule, that had brought forth two young ones, had her body laden with another sort of animalcula, whose shape was flat below, and round above, which I have observed in most waters; and this last sort were above a thousand times less than the others on which they crawled, and hindered their motion; but a much larger animalcule, whose body was almost round, tormented one of the aforesaid animalcula, not only by running upon its body, but by clinging so fast to one of its horns, that whatever effort the other made to get rid of it, she could not shake it off; and at last I found she had lost one of her horns in the scuffle.

I observed in the green weeds abundance of strange animalcula, some of which feed upon the same green stuff, and to others it serves instead of skulking holes, to hide themselves from the fish, which would otherwise devour them.

Concerning a Water-spout, lately observed at Hatfield. By the Rev. Mr. Abr. De la Pryme, F.R.S.

On the afternoon of June 21. 1702, about two o'clock, no wind stirring below, though it was somewhat great in the air, the clouds began to be much agitated and driven together; on which they became very black, and were very visibly hurried round, from whence there proceeded a most audible whirling noise, like that commonly heard in a mill. After a while a long tube or spout came down from the centre of the congregated clouds, in which was a swift spiral motion like that of a screw, when it is in motion, by which spiral nature and swift turning water ascends up into the one as well as into the other. It proceeded slowly from west to north-east, broke down a great oak-tree or two, frightened the weeders out of the field, and made others lie down flat, to avoid being whirled about and killed, as they saw had happened to several jackdaws, which were suddenly snatched up, carried out of sight, and then thrown a great way off among the corn. At length it passed over the town of Hatfield, to the great terror of the inhabitants, filling the whole air with the thatch it took off from some of the houses; then touching on a corner of the church, it tore up several sheets of lead, and rolled them together in a strange manner; soon after which, it dissolved and vanished, without doing any further mischief.

It is commonly said, that at sea, the water collects and bubbles up a foot or two high under these spouts, before they are joined: but this is a mistake, owing to the pellucidity and fineness of those tubes, which certainly touch the surface of the sea before any considerable motion can be produced in it, and that when the pipe begins to fill with water, it then becomes opaque and visible. As for the reason of their dissolving of themselves, after they have drawn up a great quantity of water, I suppose it is by and through the great quantity of the water they have carried up, which must needs thicken the clouds, impede their motion, and by that means dissolve the tubes.

Abstract of Letters relating to some Microscopical Observations.

The greatest of my microscopes shows a hair of the head considerably above an inch in diameter; and some eyes see it

at least two inches; but supposing it a bare inch, and that, as Mr. Hook affirms, 640 hairs' breadth makes one inch, the length and breadth of an object will by it be enlarged 640 times, the surface 409,600, and the solidity 262,144,000.

One of the first objects I tried my glasses by, was a living louse; in which I could plainly see the motion of the muscles, when he moved his legs; which are all joined in a longish dark spot in the middle of his breast, where the tendons seem all united. The like motion of muscles is also visible in the head when he moves his horns, and in the several articulations of his legs. I saw also clearly a multitude of various branchings of arteries and veins, and the pulse regularly beating in several arteries. But the most entertaining sight is the peristaltic motion of the intestines, which is continued from the stomach through all the guts to the anus. I have observed the like peristaltic motion in a flea, and in several sorts of small transparent maggots and caterpillars.

I thought a mite would also prove a good subject for the microscope; but found them not so transparent as I expected. However I plainly saw, that all the bristles on the body of one of them (which to a common single glass, and to the greatest magnifier of my three-glassed microscope, look like plain smooth hairs,) were, when viewed with a large magnifier, all spicated, or bearded like the ear on the seed-head of some grasses; and every bristle on the whole body and legs, both long and short, had the same formation.

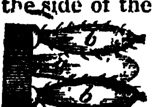
Having pulled off a handful of muscles, which stuck to a piece of a rock that was covered by the sea every tide, I found that the organs by which they fix themselves so firmly to a stone, that even a storm will not wash them off, were threads which proceeded from that part called the beard of the muscle, and which had on their extremity a flat spongy substance, that adhered only by imposition, like the suckers or wet pieces of leather which boys fasten to stones.

Some of the muscles which I brought were little more than a quarter of an inch long. I took one of these out of the shell, and exposed it to the microscope on a thin plate of Muscovy glass, and holding it to the light of a candle, I saw, in the thinner parts, a vast number of veins and arteries, and the blood circulating in them more distinctly than I ever saw it in any other animal: for I had this advantage in the observation, that the object lay always quiet, without changing place, and my plate was so thin that I could bring to it what

magnifiers I pleased, and look without disturbance as long as I pleased.

I found a small worm running among some fruit, which had a multitude of legs, and was not quite half an inch long, the body being not thicker than a hog's bristle. This insect I put alive into a small tube, and found it a perfect scolopendra, whose body was made up of 60 incisures, at every one of which was a pair of legs, one on each side, and each leg had five articulations. On his head were two horns, each of 16 joints, and under it a pair of terrible forceps, red, crooked, and pointed like the talons of a hawk; and I often saw him open and shut them, and wipe his horns through them.

I found a small black flat tick sticking on my arm, which had got its fore-part so far into the skin, that I could hardly separate it with the point of a needle, so as to preserve it entire and unhurt. I observed its snout shaped not unlike the jagged proboscis of the serra piscis: the fore-part being like the end of a broad-pointed sword, is clear and transparent, and has three teeth on each edge, below which there comes out another serrated part on each side, almost at right angles; but this is partly hid, when viewed on the back, by a thick horn *c*, on the side of the head.



I afterwards examined the snouts or proboscides of dog-ticks, to see if they had the like conformation, and found their appearance as in the fig., the snout *a* being so covered by the two clumsy thick horns *b b*, that the serrated edges could not be perceived; but separating the horns, with some difficulty, I could plainly see eight teeth, or jaggs, on each side: but the snout of a dog-tick has not the additional serrated part which is in the wood-tick. I could also perceive a tube or canal run through the snout, and see some bubbles move up and down in it.

I have found some of those animalcula in pepper-water, almost incredibly minute, which appear even to my greatest magnifiers not so large as a mite to the naked eye; and in the larger sort, I can plainly see the little feet by which they perform such brisk motions, which I never could find before. I have also discovered another sort of animalcula, which are very slender long worms, of which my pepper-water is ex-

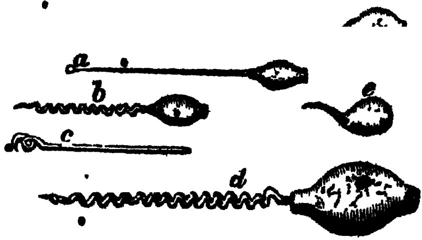
ceedingly full: they are all of the same thickness, but their lengths various, and at a medium I judge the proportion of their length to their breadth at least as 50 to one. Even to the greatest magnifiers they look like shreds of horse-hair to a naked eye; from a quarter to three quarters of an inch long; on a moderate estimate, their thickness is not the 100th part of a hair's breadth, and, consequently, if you imagine a hair of your head split into above 7800 equal fibres, each fibre would be as thick as one of these animalcules. Their motion is equable and slow, and they wave their bodies but little, though sometimes they make greater undulations. They swim with the same facility both backward and forward; so that I cannot distinguish at which end the head is, and I have seen the same worm go forward with one end, and back again with the other end foremost, above 20 times together. Sometimes they will, like leeches, fix one end on the glass plate, on which the water is laid, and move the loose part of their body round about very oddly. These I take leave to call capillary eels, and they are represented in the several postures in which I have seen them swim

I find the dust of the fungus pulverulentus, or puff ball, to be the minutest powder that I ever saw: to the naked eye, when crushed, it appears alike a smoke or vapour, and with a common microscope the particles cannot be distinguished: but when viewed with the greatest magnifiers, each grain is visible, and exactly alike, appearing a perfect spherule, of an orange colour, something transparent, whose axis is not above the 50th part of the diameter of a hair; so that a cubical vessel of a hair's breadth of a side, would hold 125,000 of them.

I have seen in some water, fishes as small as cheese-mites, of different sorts, and very curiously made: they are of the crustaceous kind; with many joints, and very long horns; fringed tails; and have many legs like shrimps; some of these carry their eggs or spawn under their tails in one bag, another sort in two distinct bags, and some kinds on the fringes of their legs, like lobsters.

The animalcula in pepper-water, represented in fig. *e*, are very common. The tails of some of these are nine or ten times as long as their body (which is about one third of a hair's breadth) but generally they are four or five times as long. As they move they will often curl up the tail in the posture marked at *b*, and this spring is so strong, that when the tail is entangled (as commonly it is) by the end,

they bring back their whole body by the jerk and convolution of the tail, which then returns to its first straightness. With a good glass, the end of the tail seems to have a knob on it as in *a*, and the folding appears as in *b*;



but examining it with one of the greatest magnifiers, I found the knob to be only a close spiral convolution, like the worm of a bottle-screw, and that the whole tail when curled up was also spiral: this appearance, with the great magnifier, is represented in *c* and *d*. I have also seen them sometimes as in *e*.

These animalcula also abound in all waters, and are the largest of all; for I can see them in a good light and position with the bare eye, their length being about the breadth of a hair. These have a very quick motion, and are perpetually beating about like a spaniel in a field, and by their frequent turns and returns, sudden stops, and casting off, seem to be always hunting for prey.

Among these are commonly another sort, but not above one third of their size, whose feet are also very visible; some of them are shaped almost like a flounder, and others are rounder behind; for by their motions and actions I judge them the same animals. These also will stand and run on a hair, or any thing in the water.

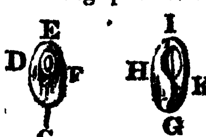
I thought those which I called capillary eels had been peculiar to pepper-water; but I have since observed the same, though but few, in some stagnant water which drained from a horse dunghill. This liquor was mum-coloured, and the most pregnant of all that I had ever seen; and it would seem incredible to say what a prodigious number of all sorts I estimated to be in a quantity of it of the size of a pepper-corn; for they appeared as thick as bees in a swarm, or ants on a hillock; so that I was obliged to dilute the water, to observe the particular sorts. I found in this not only almost all the animalcula, seen in the other infusions, but many sorts which I had never met with before.

I found a curious mechanism in a small diving insect, found in standing waters. It is like a small fly, with a head like a house-cricket; but, instead of wings, it has two paddles on the shoulders, and on the end of the hinder legs, which are longer than the other four, instead of feet and claws are perfect oars. I have also observed in two or three sorts of flies, that behind the eyes, on the top of the head, are placed three protuberances, with a black shining globe in each, like a ball in a socket, and are so disposed, as if made to look directly backwards. They are perfectly smooth, and without those hemispherical divisions visible in the cornea of the eyes of the fly and beetle kind, but appear more like those of a spider.

On the Seeds of Oranges, &c. By Mr. Anthony Van Leuwenhoek.

In November, I received a present of some Surinam oranges; and in the first I opened were 38 complete kernels: I opened several. After stripping one of these kernels of the outer membrane, I discovered that there lay a string under it, that caused a little protuberance in the first skin; from which string, not only the seed but the plant within it receives its increase and nourishment. Now we may certainly conclude, that the said string does actually comprehend in itself as many distinct vessels as are to be found in the orange-tree when arrived to full maturity; for if all these vessels were not in the young plant, while it lies involved in its mother, the kernel's matrix, whence can they afterwards proceed? Though the said string was very small, yet I was resolved to try if I could have a sight of the vessels within it, and I succeeded several times, but not without a great deal of trouble.

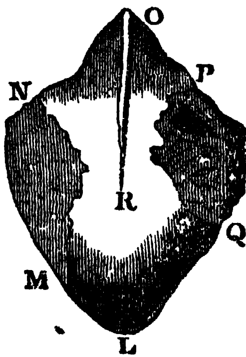
Having split the seed into two parts, one of which is represented by C D E F, together with part of the plant, which would have become a tree sticking close to it, the plant itself may be seen at C, no larger than a grain of sand to the naked eye. The counterpart of the said kernel is represented by G H I K, and G the little pit or bed of the plant; and in the said figure between H and K, the cavity in which the second seed also lay, as likewise at D F.



This sight was wholly new to me, though I had dissected many sorts of seeds before; viz. to see in the middle of one

seed or kernel another complete and perfect seed; especially when I considered that from the vessels arising out of the string, and dispersing themselves through the membranes, both the kernel and plant are produced; and yet these same vessels must insinuate themselves into the very heart of the first seed, before they can produce a second seed and plant within it.

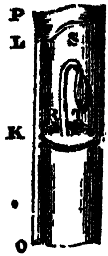
Placing the plant represented at C in the preceding fig. before a microscope, I had it dilineated L M N O P Q; where Q L M is partly that which nature intends for the body and root of the tree; N O P the leaves with which the young plant is already provided; and O P that part of the leaf which is next the sight, and somewhat protuberant, by reason of the inclosed smaller leaves. M N and P Q show the two sides of the plant torn off from the kernel, to which it was united, and from which it received its nourishment. I also turned the young plant a little about, as it stood before the microscope, to show the two largest leaves; whereas in the former position, I could see only one of them. Between the two great leaves, according to all appearance, a great many small ones are shut up; but when I came to cut the leaves across, as they lay involved in the bed of the plant, I imagined that I saw the said small leaves; and when I cut, after the same manner, that part of the plant which is to be the body and root of the tree, I discovered within the small particle that which was designed for the pith, and even the wood itself, and all as plainly as if I had been observing with my naked eye a young plant of an inch thick.

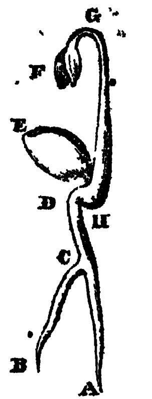


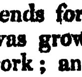
W X Y Z represent the texture of the pith, as it appeared; where may be observed a great many small particles, which at first sight one would be apt to take for irregular globules, but placed in a right line, and all of them of greater length than breadth; these I take to be nothing else but small tubes or vessels, by which the future plant receives its nourishment, and perhaps every one of them is covered with a distinct membrane.

I put one of these kernels into a glass tube, and on the 10th day I observed that the seed was come to such maturity,

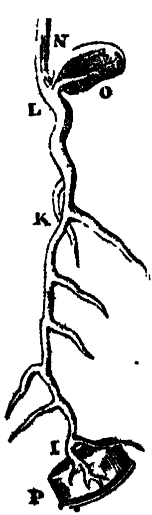
that the part which nature intends for the body of the tree was grown up as high as the cork; and on the 12th day it appeared as in the figure R S T. I then took the plant out of the glass tube, when it appeared as A B C D E F G H; only this plant had but one root, A C D H; but others have more. Here F G shows that part which is to be the tree; D E the seed or kernel, which being surrounded with its membranes I took them off, the better to expose to view those parts that serve for the nourishment, not only







of the root, but of the upper parts of the plant likewise, as also the short string D. Thus we may see with the naked eye, how a small particle, no larger than a coarse sand (as the plant is represented at C above), is increased in bulk, within the space of 11 days; and all this is effected by heat and moisture in a close vessel; a plain demonstration that the plant, and all that belonged to it, was actually in the seed; that is, not only the young plant, its body, root, and fruit, but even its seeds also, to perpetuate the species.



After one of these seeds had lain near six weeks shut up in the glass tube, and grown in proportion to that time, I observed that one of its leaves was withered or corrupted; on which I opened both the corks, and poured out the sand, which being very dry came away easily, but a small branch of the root had so insinuated itself into the cork, that it could not be separated without violence. I K L M N represents the said whole plant, of which L M N shows the body, and M the three leaves at the top, it had put forth; I K L is the root, with its twigs and branches; L N O the seed, or kernel, still surrounded with its membranes; and, lastly, I P shows the cork that stopped the bottom of the tube, with the root sticking to it.

Concerning the Figures of Sand By M. Leuwenhoek, F.R.S.

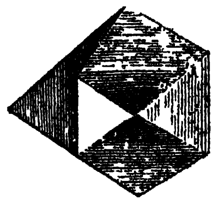
I HAVE formerly affirmed of sand, that you cannot find in any quantity whatever, two particles that are entirely alike; and though, perhaps, in their first configuration they might be alike, yet at present they are exceedingly different; the sand, especially what we make use of, is liable to such great alterations, that it would be a wonder, if even in its smallest particles, of which there may be a thousand in one small grain, there should be an exact similitude.

I got some shining sand, which, though very thin, was not transparent, its lustre being wholly occasioned by the reflection of the light from its polished sides: several particles of this sand, which were much larger than the rest, reflected no light, though they seemed smooth to the naked eye; from whence I concluded that they had lost their lustre by the frequent rubbing of their sides against others. When I viewed several grains of the sand with my microscope, I was surprised to see that many of them were hexangular, and the more when I had sifted the finest from the coarsest; neither could I observe that any of the sands were like each other. I viewed the said sand with great attention several times, imagining that by some earthquake or otherwise it might be thrown up, from the place where it had lain at rest, to the superficies of the earth; and many grains as I fancied had preserved their original shape and figure; for they had received little or no damage.

The figure represents a hexangular grain of sand, that was as bright and shining as any polished metal, and the triangular figures, which appeared on it, were as bright as the rest of the body, which occasioned a very agreeable sight.

Before one of my glasses I placed another grain of sand, less than the former, but it was flat, and not the 16th part so large as a coarse grain picked out of our common white sand. This was a surprising sight, and is represented in the engraving, where you may see not only as it were a ruined temple, but in the corner of it appear two

images of human shape, kneeling and extending their arms towards an altar, that seems to stand at a small distance from them.'



The third figure represents, as near as could be traced, another hexangular small sand, with two sharp points like pyramids, and each side that composed them very smooth and shining: I have seen several such sands, that on each side had a smooth, shining, and oblique superficies, sometimes on one single grain to the number of 24 such polished sides or faces.

I have also observed several small sands, which, instead of terminating their six sides in a sharp point, ended sometimes in a triangle, quadrangle, and even in a pentagonal or hexangular shining flatness. I remarked several three-sided sands, of which some were regular triangles, which were very thin and shining, others were thicker.

There were other sands, that were complete hexangles, the flat sides of which appeared like a steel looking-glass in a frame; and in some of them were little holes, which seemed to be likewise hexangular; whence I concluded that such a hole was made by the pressure of another sand of the like figure. When I viewed any of these sands sidewise, each of the six sides, which in the figure appear as a frame or border, seemed to be a polished looking-glass.

In short, should I undertake to give a view of 1000 others, and should enter on a strict examination of every one of them, I doubt not but we should discover every one of them to be of a different size and figure, besides several other particularities which might be peculiar to each one. I have also observed that this shining sand weighed twice as heavy as our common scouring sand. Now on taking some of the pellucid or transparent sand, (which did not shine, because it reflected no light,) I observed that the sides and angles of each grain were freer from scars and blemishes than most others I had yet considered; from whence I concluded that such sand had not lain long near the surface of the earth.

Among these shining sands, I discovered others that had no lustre at all, neither had any of their particles, when broken to pieces, but it appeared to be a dark red matter; and in other sands, so broken, there was not only a red matter, but even 100 shining particles, all proceeding from

one sand. I have also seen some sands, which in the middle of their shining sides represented small figures without lustre; but on viewing them more narrowly, I found it was a red matter, incorporated as it were in the sand. Of several sands of the coarsest sort, placed before a microscope, one seemed to represent an irregular rock of stone, another a deep cavern, &c.

I took a piece of white marble brought from Italy, which was of two sorts, the one strong, the other light and very brittle. I broke the brittle marble gently, that the configuration of the small particles might not be much altered; and having viewed several of them with my glass, I saw abundance of surprising particles, which may justly be styled sands, with their regular sides and angles, and many of them of the same figure as the shining sand.

We may well conclude, that the grains of sand which compose such stones, were not only soft at the time of their coalition or union with each other; but that at the same time there intervened a very inflexible fixed salt, instead of mortar, between the particles of sand; unless you choose to say, that each particle of salt in some degree consists of such fixed salts.

After this I took a piece of hearth-stone, so soft, that I could easily crumble it between my fingers; and afterwards viewing it with one of my glasses, could perceive nothing but particles of sand, without the least smooth side, or regular angles; and it seemed to me, that this sand had acquired a sort of conglutination, or was grown into a solid substance, which we call stone, a long time after it had been nothing but sand, and its particles had been worn and collided against each other.

After this, I took a small piece of mineral stone, brought from Sumatra, which was so rich, that 100 cwt of it contained near 50 gilders of silver, and 30 of gold: the piece was about the size of a common bean; and putting it over a pretty smart fire, the sulphur, of which there was a great deal in the mineral, stood in bubbles, and remained on the stone in the figure of round, black, burnt globules; I then dropped it red hot into water, where it remained whole, only with this difference, that whereas before it was very firm, now it became very brittle; and having broken it, I perceived it to consist chiefly of irregular particles, though some few were of an exact diamond-cut; and I could see, much more plainly than before, the globules of gold and silver, lying separately from one another, some of the former of which were

so exceedingly small, that they almost escaped the sight in the microscope.

A New Division of Terrestrial Brute Animals, particularly of those that have their Feet formed like Hands. By Edward Tyson, *M. D. F. R. S.*

We may observe these differences between the fingers and toes of the ape kind and carnivorous animals, that, in the former, the fingers are much longer, having usually a thumb set at a distance from the range of the other fingers; and are adapted for holding what they grasp; and especially to assist them in climbing trees, &c. for catching their prey. Whereas in the latter, the toes are shorter, and are set in a more even range together, and better contrived for swift running, by which way this sort of animals take their prey.

We shall not, in this place, consider further the structure of the feet of carnivorous animals, but give a subdivision of those animals which have their feet formed like hands. Now where there is a thumb, though we may esteem the hand there more perfect, yet I find it is not always necessary

Under the first member of this division I include the ape and monkey kind, which, as I have shown in my discourse on the ourang-outang, ought rather to be reckoned a four-handed than a four-footed animal. And considering how large a species of animals may be reduced under this quadrumanous kind, agreeing in this particular, though in others different, I think it but just to assign them a general class, afterwards to be subdivided according to the gradual differences they have from one another.

The romack, therefore, though differing much from the monkey kind in the head and face, yet being quadrumanous, and on each hand having a thumb, I reduce under this head. This animal was brought alive from Fort St. George. Whether it is described by any, or what other names it is called by, I know not. And because in its face and head it so much resembles a fox, and in the rest of its body a monkey, I shall call it the fox-monkey. But the next I have mentioned in this class, the coati of Brasil and Virginia, or the rackoon or rattoon, though it does not resemble the monkey kind in its body, yet because it has hands like a monkey, I place it likewise here; as well as all others whose feet are all formed like hands, and have a thumb on each.

For there are some that have not a thumb on their fore-feet, and others that want one on the hinder. In the number of the former may be reckoned the vantrevan, the squirrel

kind and mouse kind, or any others that may be observed to have all their feet formed like hands, only that their fore-feet want the thumb. The vantrevan altogether resembles a monkey: on the fore-feet it had only four long fingers, but no thumb. It is a beautiful animal, very brisk and nimble in motion, and is loving; it has a very long tail, by which it suspends its body as the opossum does.

The squirrel kind has on the fore feet four long fingers, on the hind-feet five, and one like a thumb. It uses its fore-feet like hands in holding up its food to its mouth, and lives on trees, as monkeys do. But the affinity between the monkey and squirrel kinds appears better by some monkeys I have seen, which on the belly have a large thick fur, and a thick brushy tail like the squirrel; whereas usually the ape and monkey are thinner of hair on the belly, and that on their tail is shorter. This sort of monkey I call therefore the squirrel-monkey, or sciuro-pithecus. But its face more resembled a man's or an ape's, as likewise its teeth, and in these respects it differs much from the squirrel kind.

Nearer to the squirrel comes the mouse kind, which in the shape of its head, the long teeth before, and the large and prominent eyes, it more resembles; and it uses its fore-feet as hands in feeding itself, where it has four fingers without a thumb, but on its hinder feet it has five, of which the innermost and outermost are placed at a distance from the range of the three middle fingers, like two thumbs, as may be observed in some of the lizard kind.

We come next to those animals that have only two feet formed like hands, and those are either the fore-feet or the hinder. Those whose fore-feet only are formed like hands have either a thumb there, as the mantegar, &c. or have only four fingers without a thumb, as the cuandu, &c. The mantegar, when sitting and supporting itself by a stick in one hand, erect, and holding a cup in the other, would drink out of it, and not lap: its food was chiefly fruits.

Among those animals whose fore-feet are like hands, and have no thumb, I reckon the porcupine kind: as the cuandu of Brasil, a sort of porcupine described by Margrave and Jo. Nieuhoff, (Voyages. p. 18.) which on the fore-feet has only four fingers, on the hinder, five. Therefore, as Margrave observes, for want of a thumb, it is but slow in climbing trees; but the better to help itself it twists its tail about a bough to save itself from falling. And much alike, if not the same, is the tlaquatzin spinosum of Hernandez. Also the common porcupine. before has four fingers, behind five. So the tamandua

of Brasil, or ant-bear, before has only four fingers, where the want of length in the fingers is supplied by that of the nails, and behind it has five toes. But I must confess there must be some allowance made for ranging this anomalous animal, as Mr. Ray calls it, here; but because he climbs trees, and in doing this makes use of his tail, as some others here mentioned do, I was willing to include him with the rest. And we may likewise bring in here the ai, the ignavus, or sloth, because it climbs and lives on trees, and has a head not unlike an ape's; and, as Margrave assures us, two teats on the breast, but on each foot only three claws, with very long nails, like the tamandua, and its feet being very narrow and thus defective in toes, it is very slow in motion. Among the animals whose hinder feet only are like hands, is to be reckoned the carigueya or opossum.

Concerning Harwich Cliffs, and the Fossil Shells found there. By Mr. Samuel Dale.

Harwich cliff is a sort of promontory, which divides Orwel haven from the æstuarium contained between that and Walton Nase: it is situated near a quarter of a mile distant to the south of the town, and contains many acres of land: its greatest height, from the strand or beach to the top, is 40 or 50 feet. At the bottom of this cliff is a stratum of clay, which is succeeded by another of stone, each about a foot thick; in this stratum of stone are imbedded divers shells (though but thinly) as well of the turbinate as bivalve kind, and also pieces of wood and sticks. Over this are divers strata of bluish clay, about the height of 20 feet: this clay has pyrites or copperas stones sticking in it, but I could observe no shells. Above this are likewise divers strata, which reach to within about two feet of the surface; some of which are only of fine sand, others small stones and gravel, mixed with fragments of shells, and in others small pebbles are mixed; and it is in some of these last-mentioned strata, that the fossil bivalve and turbinate shells are imbedded, which lie promiscuously together: the strata with the shells observe no order in their lying, being sometimes higher and sometimes lower in the cliff; and sometimes two or three one above another, with other strata of sand, fragments, and gravel between.

How those shells or marine bodies came to be deposited here, is a subject which has employed the heads and pens of several learned and ingenious men. I shall therefore only make some remarks on the positive assertion of a recent

author, concerning the imbedding of these fossil shells in this cliff, and the alteration of the channel, viz. "That this bed of shells, which covers the cliff, was carried thither at the making of the harbour or clearing of it. For the harbour or channel there is artificial, and of no old date, the current having been formerly on the other side of Languard Fort, which then stood in Essex." Against the first part of which, although many reasons might be given to prove the contrary, I shall only observe, that as our author begs the question, How else could the shells lie at the top of this cliff? I shall also ask him, Why the same strata of sand, and fragments of shells, with the same fossils imbedded, are to be found at Walton Ness on the other side of the æstuarium, which is five or six miles broad from Harwich, as also at Bawdsey cliff in Suffolk, which is eight or nine miles distant, and in other cliffs on that shore, where I have met with them?

A second question may here be asked, How it comes to pass, that none of those buccina heterostropha (whose exuviæ are in such plenty in all the cliffs hereabouts) are not now to be found in this channel, nor the adjacent seas? For I cannot think the clearing this harbour could have destroyed all that species of shell-fish, of which there was then such plenty; and therefore some other origin must be allowed them than what this author has assigned.

I have already noticed, that the fossil shells are imbedded in a loose stratum of sand, gravel, &c. which may serve to demonstrate, that their matrix is not a clay-bed on the top of the cliff; as also, that they could not be scattered there by crows, gulls, and other sea-fowl, as well as that some of them are likewise bedded in stone at the bottom of the cliff; and although some few of them may be met with on the top of the cliff, yet it is only where the earth has been broken by the digging of ditches, &c.

An Account of Cochineal. By Mr. Anthony Van Leuwenhoek, *F.R.S.*

"There is a certain plant called the prickle pear, or Indian fig; the leaves of which are round and thick, and sharp pointed: that upon the leaves or twigs of the said plant are small knobs or protuberances, from whence are produced, by the heat of the sun, little worms; these worms in process of time become flies, in likeness to cow-ladies or lady-birds, as some call them, which, when they are arrived to their full growth, are taken in this manner: to windward of the plant,

on which these animals are found, they kindle a fire of any combustible matter, having first spread cloths under and round about the said plant, with the smoke of which they are presently suffocated; then shaking the tree, they receive them upon those cloths in great numbers, and with very little trouble; after which they spread them abroad in a like cloth on a sandy place, or a stone floor, where they are exposed to the heat of the sun till they are dried, that is, till their small bodies are shrivelled up together, and rubbed between the hands till their wings, legs, &c. fall off, which are garbled out, and then the remaining trunks of the animals are put into shallow copper boxes, till they become quite dry. The aforesaid plant has no flowers or blossoms on it, and its fruit is of a fleshy substance and red, and when ripe, by handling it, the fingers will look as if they were stained with mulberries. Some say, that the cochineal worms feed on the blossoms and fruit of this plant, which causes their bodies to be of that red colour. And that if you take the seed of the plant or the dead worms, and dry them after the above-mentioned manner, that cochineal is not so good as when those animals have got wings, and are then smothered.

Now for further satisfaction, I took several particles of this same cochineal, both of the largest and smallest, and having dissected them, I found that they had all eggs in their bellies, excepting only one that was exceedingly small. Having opened some of the largest trunks, and separated the eggs, which I took out of their bodies, and counted them, I judged that there were above 200; and having observed several of them with my microscope, I could perceive not only a membrane or shell on most of them, but also an animalculum of an oval shape included in the said shell, and almost as large as the shell that contained it, which seemed at first very surprising, and almost incredible in so small a species of fly as the cochineal, till by a very nice and long enquiry I was fully satisfied, that it was really an animalculum that lay within it. I pursued this operation with so good success, that I not only separated the egg-shell from the animalculum, but in some of them I could perceive their legs also orderly folded up against their body, and could separate them from it, especially in such as were full grown; nay, in some I even discovered the several joints of the legs, and thus in the space of two days I saw the legs of 100 animalcula, many of which in my handling were broken off, and lay by themselves.

On viewing some of these embryos, after having divested them of the membrane or shell in which they were shut up,

I observed on their head a kind of a tool or instrument, about a fifth part as long as the whole body of the animalculum, and at the extremity a very slender point, something like that instrument which those animalcula have that are found on currant bushes, &c. and by which they get their food; and when they have so done, they clap it to their breasts till they have occasion for it again. From whence I infer that the cochineal flies also acquire their food after the same manner, viz. that they have no teeth to gnaw the leaves of the plant, as silk worms do, but that they only insinuate their said instrument into the leaves, and after that manner get their nourishment. And this notion seems to be supported by what an old Spaniard said, viz. that these animalcula feed on the blossoms and fruits of the plant, and that by those means they became red. From hence we may conclude, that the insects do not hurt the leaves, fruits, nor even the blossoms of trees, as far as we can discover; which may also the better satisfy us, that the cochineal flies, with the above-mentioned instrument, by boring into the leaves, acquire both their food and increase.

The cochineal flies in all appearance dwell on the back or underside of the leaves, which defend them from the great heat of the sun in those climates; and as the smoke cannot destroy all those flies, the few that remain must multiply very much in a short time. I had got about a spoonful of powder or dust together with some sands, out of the cochineal box, and found that what appeared to be nothing but dust, was abundance of very small cochineal flies, and some of them so minute, as if they had been just hatched, and some of them gradually larger than others; there were also other small particles, which I judged to be the excrements of the animalcula; I saw also abundance of legs with three joints, and some also that had but two joints, and a few one joint only; among these legs, some had claws on, which were either white, or dark coloured, or of a light red.

Concerning Animalcula on the Roots of Duck-weed. By M. Leuwenhoek, F. R. S.

In October, 1702, I caused the dirt of the gutters, when quite dry, to be gathered together, and taking a small quantity of it, I put it into a paper on my desk; since which time, I have often taken a little of it, and poured on it boiled water, after it had stood till it was cold, that I might obviate any objection that should be made, as if there were living creatures

in that water. These animalcula, when the water runs off or dries away, contract their bodies into a globular or oval figure. After the said dry substance had lain near 21 months in the paper, I put into a glass tube, of an inch diameter, the remainder of what I had by me, and poured on it boiled rain water, when it was almost cold; and then immediately viewed the smallest parts of it, particularly that which subsided leisurely to the bottom, and observed a great many round particles, most of which were reddish, and were certainly animalcula; some hours after I discovered a few that had opened or unfolded their bodies, swimming through the water, and a great many others that had not unfolded themselves were sunk to the bottom. Next day I saw three particular animalcula swimming through the water, the smallest of which was 100 times smaller than the above-said animalcula.

So that it is surprising that these small insects can lie 21 months dry, and yet live; and as soon as ever they are put into water begin to swim, or fasten the hinder parts of their bodies to the glass, and then protrude their wheels, just as if they had never wanted water.

In the month of September, I put a great many of the last-mentioned animalcula into a wide glass tube, which presently placed themselves on the sides of the glass; whereupon, pouring off the water, I then observed that several animalcula, to the number of 18 or 19, lay by each other in the space of a coarse sand; all which, when there remained no more water, closed themselves up in a globular figure. Some of the bodies of these animalcula were so strongly dried-up, that one could see the wrinkles in them, and they were of a reddish colour; a few others were so transparent, as if they had been little glass balls, that if you held them up between your eye and the light, you might move your fingers behind them, and see the motion through their bodies.

After these animalcula had lain thus dried up a day or two, in an oval or globular form, I poured some water into the glass tube, whereupon they presently sunk to the bottom; and after the space of about half an hour they began to open and extend their bodies, and getting clear of the glass, to swim about the water, excepting only two of the largest, that staid longer on the sides of the glass, before they stretched out their bodies and swam away.

After I had poured the water from them, in order to see how they brought their bodies into that orbicular form; viewing two of the largest of them, I observed that they stretched out their bodies in the space of a minute, several

times, to an extraordinary length, and thrice opened the hinder part of their bodies, and discharged some excrements, which, in the little water that remained about them, were dissolved into small pellets, before they assumed their round figure.

In the month of October, before the dirt of the leaden gutter was quite dried up, I took a handful of it, and laid it on a glazen earthen dish, in order to preserve it. This foul stuff, when dry, is as hard as clay, so that the mites cannot come at the animalcula that are thus doubly shut up. Upwards of 21 months after I took some of this dry stuff, and infused it both in cold water that had been boiled, and in rain-water newly fallen; whereupon the animalcula began to show themselves, and that in great numbers; and soon after there appeared two sorts of much smaller animalcula.

Of the Rain at Towneley, in Lancashire, Upminster in Essex, Lisle, and Paris. By the Rev. W. Derham, F.R.S.

At Lisle one year with another, the depth of the rain amounts to 22 inches 3 lines, Paris measure, or 23 inches 3 lines, which makes about 23½ inches English or 24¼. At Paris, one year with another, it amounts to 20 inches 3½ lines, Paris measure, which is near 22 inches English. But at Towneley, in Lancashire, one year with another, according to Mr. Towneley's computation formerly, the rains amount to above 41 inches depth. And by taking eight other years, in which the rain was observed both at Towneley and Upminster (viz. from 1696 to 1704), I find that all the eight years' rain at Towneley amounts to above 1700 lines Troy, at Upminster 823 lines only. Which said sums being divided by 8, give 212½ lines one year with another, at Towneley, and near 103 lines at Upminster. Each of which sums being doubled, and making a decimal fraction of the last figure, gives nearly the number of inches, which all the rain would have risen to, if the earth had stagnated, viz. 42½ inches at Towneley, and about 20½ inches at Upminster. Wherefore the rain at Upminster is less than at Paris, at Paris less than at Lisle, and at every one of the places much less than at Towneley.

An Experiment made at a Meeting of the Royal Society, on the Diminution of Sound in rarefied Air. By Mr. Fr. Hauksbee.

A Bell being included under a receiver, which being shaken to make the clapper strike, it was very observable

that the interposition of the glass between the bell and the ear, was a great obstruction to its sound, yet it was audible at some good distance from it: but gradually withdrawing the air, and making several stops to shake the bell at different degrees of rarefaction, the diminution of the sound at every stop was very distinguishable. Till at last, when the receiver was well exhausted of air, the remains of sound was then so little, that the best ears could but just distinguish it: it appearing to them like a small shrill sound at a great distance. On suffering the air gradually to re-enter, it was easy to perceive the increase of sound at the different times the bell was made to ring: the recipient being again replete with air, the sound then seemed something more clear and audible than at its first inclusion.

Experiment on the Descent of Malt Dust in the evacuated Receiver. By Mr. Fr. Hauksbee.

I took some malt dust, and having dried it well, put a quantity of it into a fine muslin bag, where being loosely inclosed, it would upon shaking discover itself plentifully in the open air, undulating and floating a considerable time before it would descend; but being included within a receiver, from which the air was well exhausted, and then shaken, the dust descended like a ponderous body, precipitating in straight lines from the top to the bottom of a tall receiver.

The Doctrine of Combinations and Alternations. By Major Edward Thornycroft.

To give an instance of the prodigious variety that there is in music, I have calculated the number of tunes in common time, consisting of eight bars each, which may be played on an instrument of one octave compass only, and it is this; viz. 27584.270157.013570.368586.999728.299176; whereas the changes on twenty-four bells are not more than 620448.401733.239439.360000, which is but the $\frac{1}{444.88.604383}$ part of the number of tunes; and yet Dr. Wallis, in his algebra, demonstrates, that the changes on bells could not be despatched in 31557.600000 000000 years. If, then, the instrument were of as many octaves' compass as any instrument now in use, how prodigiously must the number of tunes be increased; the calculation of which (though much more intricate and operose) would be equally attainable by our theorem.

Of Ancient Manuscripts. By Mr. Humfrey Wanley.

The librarii or book-writers were, from the time of the Romans, a particular company of men, and their business a trade: but though book-writing was their profession, yet they afterwards had but a third part of the business. Learning, after the erection of monasteries, was chiefly in the hands of the clergy; and they were for the most part regulars, and lived in monasteries: among these were always many industrious men, who wrote continually new copies of old books for their own use or for the monastery, or for both; which seems to have swallowed up above half the business. Then, if an extraordinary book was to be written, for the standing and more particular use of the church or monastery, the antiquarius must be sent for, to write it in large characters, after the old manner, and such a copy they knew would last for many ages, without renovation. Between these two sorts of people, the writing-monks and antiquarii, the poor librarii, or common scriptores, who had families to maintain, could hardly earn their bread. This put them upon a quicker way of despatch, that so they might undersell each other: and in order to this despatch, they would employ several persons at one time, in writing the same book, each person, except him who wrote the first skin, beginning where his fellow was to leave off: or else they would form the letters smaller and leaner, and make use of more jugations and abbreviations than usually others did. And this is the only account that I can give for that variety of hands which in former ages, being learned of, or borrowed from the Romans, was commonly used, and in fashion at the same time, and in the same country, throughout these western parts of Europe, and for their growing less and less for one age after another.

There was another sort of book-writers still in use, namely, the notarii, whose business it was to take trials and pleadings at courts of judicature; to write as amanuenses from the mouth of an author, and to take homilies and sermons at church, from the mouth of the preacher. These notarii made use of notæ or marks instead of letters; but when, in process of time, letters were usually written small and quick, and abbreviations grew common, the notarii were turned off, unless they would write books in long-hand, as other librarii did, and their notæ grew out of use; and most of their performances in notes or marks have been since destroyed.

Suppose, then, that a man had one Latin book of each of the four sorts above mentioned laid before him, written all at a

time, and without any date or note of the age; would not he be ready to say that the first three were of different ages? As that in capitals was older than that in the middling hand; and this again older than that in the running and smaller hand? and that such a book written in the notæ being all full of marks, was not Latin, but of some other unknown language? But to come down later; suppose that a person should have some more recent books or charters laid before him in the pipe, text, exchequer, chancery, court, and common hands, all written at the same time, would he not be apt to say, that one seemed to him to be older than another, and that they were the hands of several nations?

Experiments on the Attrition of Bodies in Vacuo. By Mr. Fr. Hauksbee, F.R.S.

Showing the Necessity of the Air's Presence, in the Production of Fire, on the Attrition of Flint and Steel.—Having provided a steel ring, about four inches diameter, and one eighth of an inch thick, which (between two pieces of wood of a less diameter) I fixed on a spindle with the nuts; its edge verging about half an inch beyond the extremity of the wood that held it; to a plate of brass, I fixed a piece of flint, an edge of which stood exposed to the steel, while the brass plate by its spring held the flint pretty strongly to it, notwithstanding some might be worn or chipped off by the rapidity of the motion. In this manner it was covered with a receiver, and a brass plate and box. But before any air was exhausted, the great wheel was moved, which gave motion to the small one, and consequently to the included steel, which exhibited sparks of fire in a very plentiful manner. After some air had been withdrawn, the great wheel was turned, as before, but the number of sparks then produced did not only seem to be lessened, but a sensible decay of their lustre and vigour was manifest. And at every stop that was made, to repeat the experiment at greater rarefactions, the sparks produced still diminished in their quantity and light; till at last, when the receiver was well exhausted of air, then, although a more violent motion was given to the steel than before, yet not the least spark appeared to be struck from it: but a small continued light was visible on the edge of the flint, that was rubbed by the steel. On admitting a little air, some sparks, on the motion given, were discovered of a dull gloomy hue; but on letting in a little more air, I

know not by what accident, the whole quantity insinuated, and then on repeating the wheel's motion, the sparks appeared as numerous and as vivid as the first.

An Account of an extraordinary sleepy Person. By Dr. WILLIAM OLIVER, *F.R.S.*

SAMUEL CHILTON, of Tinsbury, near Bath, a labourer, about 25 years of age, of a robust habit of body, not fat, but fleshy, having dark brown hair, happened, on the 13th of May, 1691, without any visible cause, to fall into a very profound sleep, out of which no means employed could rouse him, till after a month's time; when he rose of himself, put on his clothes, and went about his business of husbandry as usual; he then slept, ate and drank as before, but spake not one word till about a month after. All the time he slept, victuals stood by him: his mother fearing he would be starved, in that sullen humour, as she thought it, put bread and cheese and small beer before him, which was spent every day, and, it was supposed by him, though no one ever saw him eat or drink all that time.

From this time he remained free of any drowsiness or sleepiness till about the 9th of April, 1696, when he fell into his sleeping fit again, just as he did before. After some days his friends were prevailed on to try what effect medicines might have on him; and accordingly, one Mr. Gibs, an apothecary, bled, blistered, cupped, and scarified him, and used all the external irritating medicines he could think on; but all to no purpose; and after the first fortnight, he was never observed to open his eyes. Victuals stood by him as before, which he ate of now and then, but nobody ever saw him eat or evacuate, though he did both very regularly, as he had occasion; and sometimes they have found him fast asleep with the pot in his hand in bed, and sometimes with his mouth full of meat. In this manner he lay about 10 weeks, and then he could eat nothing at all; for his jaws seemed to be set, and his teeth clenched so close, that with all the art they used with instruments, they could not open his mouth, to put any thing into it to support him. At last, observing a hole made in his teeth, by holding his pipe in his mouth, as most great smokers usually have, they now and then poured some wine into his throat through a quill: and this was all he took for six weeks and four days; and of this, not above three

pints or two quarts, some of which was spilt also; he had made water but once, and never had a stool all that time.

August the 7th, which is 17 weeks from the 9th of April, when he began to sleep, he awaked, put on his clothes, and walked about the room, not knowing he had slept above a night, nor could he be persuaded he had lain so long, till going out into the fields he found every body busy in getting in their harvest, and he remembered very well, when he fell asleep they were sowing barley and oats, which he then saw ripe and fit to be cut down.

There was one thing observable, that though his flesh was somewhat wasted with so long lying in bed, and fasting for above six weeks, yet a worthy gentleman, his neighbour, assured me, when he saw him, which was the first day of his coming abroad, he looked brisker than ever he saw him in his life before; and asking him whether the bed had not made him sore, he assured him that he neither found that nor any other inconveniency at all; and that he had not the least remembrance of any thing that passed, or was done to him all that time. So he fell again to his husbandry, as usual, and remained well from that time till August the 17th, anno 1697, when in the morning he complained of a shivering and coldness in his back, vomited once or twice, and the same day fell into his sleeping fit again.

Being then at Bath, and hearing of it, I took horse on the 23d, to inform myself of a matter of fact I thought so strange. I found him asleep, with a cup of beer and a piece of bread and cheese on a stool by his bed, within his reach: I took him by the hand, felt his pulse, which was at that time very regular; I put my hand on his breast, and found his heart beat very regular too, and his breathing was easy and free; and all the fault I found was, that I thought his pulse beat a little too strong. He was in a breathing sweat, and had an agreeable warmth all over his body. I then put my mouth to his ear, and as loud as I could called him by his name several times, pulled him by the shoulders, pinched his nose, stopped his mouth and nose together, as long as I durst, for fear of choking him; but all to no purpose, for in all this time he gave me not the least sign of his being sensible. I lifted up his eye-lids, and found his eye-balls drawn up under his eye-brows, and fixed without any motion at all. Being baffled in all these trials, I was resolved to see what effect spirit of sal ammoniac would have, which I had brought with me, to discover the cheat, if it had been one; so I held my phial under one nostril a considerable time, which being

drawn from quick-lime, was a very piercing spirit, and so strong I could not bear it under my own nose a moment without making my eyes water; but he felt it not at all. I then threw it, at several times, up the same nostril; which made his nose run and gleet, and his eye-lids shiver and tremble a very little; which was all the effect I found, though I poured up into one nostril about a half-ounce bottle of this fiery spirit, which was as strong almost as fire itself. Finding no success with this neither, I crammed that nostril with powder of white hellebore, which I had by me, in order to make my farther trials, and I can hardly think any impostor could ever be insensible of what I did. I remained sometime afterwards in the room, to see what effect all together might have upon him; but he never gave any sign that he felt what I had done, nor discovered any manner of uneasiness, by moving or stirring any one part of his body, that I could observe. Having made these experiments, I left him, being pretty well satisfied he was really asleep, and no sullen counterfeit, as some people supposed.

On my return to Bath, and relating what I had observed, many gentlemen went out to see him, as I had done, to satisfy their curiosity, who found him in the same condition I had left him the day before; only his nose was inflamed and swelled very much, and his lips and the inside of his right nostril blistered and scabby, with my spirit and hellebore, which I had plentifully dosed him with the day before: his mother upon this for some time after would suffer nobody to come near him, for fear of more experiments on her son. About ten days after I had been with him, Mr. Woolmer, an experienced apothecary at Bath, called at the house, being near Tinsbury, went up into the room, finding his pulse pretty high, as I had done, took out his lancet, let him blood about 14 ounces in the arm, tied his arm up again, nobody being in the house, and left him as he found him; and he assured me he never made the least motion in the world when he pricked him, nor all the while his arm was bleeding.

Several other experiments were made by those that went to see him every day from Bath, but all to no purpose. I saw him myself again the latter end of September, and found him just in the same posture, lying in his bed, but removed from the house where he was before, about a furlong or more; and they told me, when they removed him, by accident, carrying him down stairs, which were somewhat narrow, they struck his head against a stone, and gave him a severe knock, — broke his head, but he never moved any more at it

than a dead man would. I found now his pulse was not quite so strong, nor had he any sweats, as when I saw him before. I tried him again the second time, by stopping his nose and mouth, but to no purpose; and a gentleman then with me ran a large pin into his arm to the very bone, but he gave no manner of token of his being sensible of any thing we did to him. In all this time they assured me nobody had seen him either eat or drink, though they endeavoured it all they could; but it always stood by him, and they observed, sometimes once a day, sometimes once in two days, all was gone. In this manner he lay till the 19th of November, when his mother hearing him make a noise, ran immediately up to him, and found him eating; she asked him how he did? He said, Very well, thank God: she asked him again, which he liked best, bread and butter, or bread and cheese? He answered, Bread and cheese: upon this, the poor woman overjoyed left him to acquaint his brother with it, and they came straight up into the chamber to him, but found him as fast asleep again as ever, and all the art they had could not wake him. From this time to the end of January, or the beginning of February, he slept not so profoundly as before, for when they called him by his name, he seemed to hear them, and to be somewhat sensible, though he could not make them any answer. His eyes were not now shut so close, and he had frequently great tremblings of his eye-lids; on which they expected every day he would wake; which however happened not till about the time just now mentioned; and then he waked perfectly well, not remembering any thing that happened all this while. It was observed he was very little altered in his flesh, only complained the cold pinched him more than usually, and so presently fell to husbandry, as at other times.

Account of River and other Shells, with various Vegetable Bodies, found under Ground. By the Rev. Mr. MORTON, *A.M. and F.R.S.*

ON digging a moorish pasture in Mears-Ashby field, in Northamptonshire, we found a vast number of snail-shells of various kinds. At about a foot deep they lay very thick: and digging downwards, the number rather increased till we came to the depth of about three feet. It was troublesome to sink deeper on purpose; but we made trials for a considerable extent of ground, viz. about 250 feet in length, and 130 in breadth. Besides, the same shells were thrown up in several places by the moles. What we principally observed

in this search was, 1. A moist moorish black earth, in some places a foot and a half, in others somewhat above two feet in thickness. The lower half of it is blacker and denser than the upper, is of a bituminous nature, and has all the characters of peat-earth. Besides shells, we found stalks and leaves of grass, and also of many other vegetables reposited, as usual, in like bituminous moors. 2. White earth; so at first we called it: but on closer inspection, it appeared to be little more than hay half wasted. So deep as we sunk into it, we found it every where copiously interspersed with shells.

An Account of the Death and Dissection of John Bayles, of Northampton, reputed to have been 130 Years old. By Dr. James Keill.

John Bayles, the old button-maker of Northampton, is commonly reputed to have been 130 years of age when he died. There is no register so old in the parish where he was christened; but the oldest people, of which some are 100, others 90, and others above 80 years, remember him to have been old when they were young. Their accounts, indeed, differ much from each other, but all agree that he was at least 120 years. He himself always affirmed that he was at Tilbury camp, and told several particulars about it; and if we allow him to have been but 12 years old then, he must have been 130 when he died, which was the 4th of April 1706; having lived in three centuries, and in seven reigns.

He used constantly to walk to the neighbouring markets with his buttons within these 12 years; but of late he has been decrepid, and carried abroad. There was nothing particular in his diet, but he ate any thing he could get. His body was extremely emaciated, and his flesh feeling hard, the shape of all the external muscles was plainly to be seen through the skin.

A due conformation of all the vital parts is most certainly necessary to bring a man to a full old age; but above all the rest, there are two which to me seem to have had the greatest share in procuring a longevity to old Parr and Bayles, by retarding the ill effects just now mentioned: the first is the heart, which in both was strong and fibrous; for that being left alone to labour the circulation of a large quantity of languid blood, a great force is absolutely requisite to propel it through unactive vessels, to the extremities of the body and back again: no doubt this is more easily done in men of a low stature (as old Bayles was) which I am apt to

think is a qualification to old age. The second was the largeness of their chests, and goodness of their lungs, by which the air had its full effort on every particle of the blood, in rendering it florid, and attenuating it so that it might easily move through the contracted channels of an old body. Few have the happiness of such a heart and lungs, yet most men wish to live long; nor was it easy for physicians to give rules for preventing the ill consequences of extreme old age, while the effects of a long circulation of the blood were unknown; of which we can be certain only by dissections of old persons, and these are not numerous enough to ground any thing certain upon: but if future observations shall confirm the remarks that have been now made, no doubt the indication will be to preserve such a softness in all the fibres, that they may easily yield to the pressure of the blood, and by their elasticity restore themselves to their former state, thereby giving a new impetus to the blood.

Experiments and Observations on the Motion of Sound, &c. By the Rev. Mr. Derham, Rector of Upminster, and F.R.S.

To determine the velocity of sound, I caused guns to be fired from towers, and other eminences, at the distance of one, two, three, to eight miles: the guns that served this purpose best were those at Blackheath, called sakers, whose flashes I could see from the turret of Upminster church, and hear the report almost in all weathers, and even in the day-time I could with the telescope observe the flash.

The following experiment was made at that place; viz. two guns, called sakers, were planted near each other, with the muzzle of one turned towards me, and that of the other from me, and on February the 13th, 1705, they were fired every half hour, from six o'clock in the evening till midnight, a gentle wind blowing directly against the sound; the time between the flash of each explosion (which I could observe with the naked eye) and the report was always about 120 or 122 half seconds; for the report was double; the first, which was weaker, reached in about 120 half seconds, and the other, which was stronger, in about 122 half seconds; and in the same manner there was a double report of each explosion during the whole time of the observation.

To confirm all this, I went to Foulney-sands, on the Essex coast, which form a large and regular plain, of several miles in length: there I measured six miles, and almost at the end of each mile made experiments, by firing guns; by which I

found that all my former observations were very just and true; viz. that sound moves a mile in 9 half seconds and ¼, two miles in 18 and ½, and three miles in 27 half seconds and ¾, and so on.

I caused guns to be fired every half hour, from six in the evening till midnight, and found the report always reach the ear, without any remarkable variation, in 120 or 122 half seconds of time, though the wind was directly against it; but at other times, when the wind was favourable, and blew either direct, transversely, or obliquely: on observing the report of the same guns reach in 111, 112, 113, 114, 115, 116, or at most in 117 half seconds of time, I was at length assured, that some real difference caused this variety in the observations. And not only do winds with or against the sound accelerate or retard its motion, but likewise according to the variou degrees of their strength and weakness, is the sound more or less promoted or impeded; of which I made particular observations.

The greatest difference I have observed in the motion of sound in the space of about 13 miles, was about 9 or 10 half seconds, when a strong wind promotes, and only a gentle wind impedes it; but when only a gentle wind, or almost none at all, opposes or favours the sound, the difference hardly exceeds two or three half seconds.

To discover the quantity of space that winds pass over in any given time, I took some light bodies, such as down, &c. and from the several experiments I made with these, when the strength of the wind was different, found that the strongest wind scarcely passed over 60 miles in an hour; for instance, on August 11. 1705, the violence of the wind was such, as almost to beat down a windmill, near the place where I made my observations; and estimating by the numeral characters, 0, 1, 2, 3, 4, 5, 6, to 10, 15, or more degrees, the strength of winds, the strength of this I reckoned at about 12 or 14 of these degrees: and from repeated experiments I found, that that hurricane passed over about 33 feet in a half second of time, or 45 miles in an hour; whence I conclude, that in the most violent storms, not excepting that in Nov. 1703, the wind does not traverse above 50 or 60 miles in an hour.

Having thus determined the velocity of rapid winds, we may from hence more easily conjecture the velocity of such as are less so; and I have found from several experiments, that some of them move 15 miles, others 13, some more and some fewer, in an hour; and that others again have so slow a motion, as scarcely to pass over one mile in an hour: also

some are so slow, that a person, walking or riding, may easily outrun them, as is apparent to sense.

From what has been said above, I firmly conclude, that sound is propagated with this degree of velocity, viz. that in 9 half seconds and ¼ it moves the space of a mile, or 5280 English feet; or, which is the same thing, 571 feet in a half second of time, or 1142 feet in a whole second. Thus, sound moves through the above space, if the flux of the atmosphere or wind be transverse or across, and is its mean motion; but should the wind increase the rapidity of sound, it is possible that it may move upwards of 600 feet in a half second of time; or, on the contrary, should it retard sound, it may move not above 560 feet in the same time.

New Island raised near Sant-Erini, in the Archipelago. By Dr. W. Sherard, Consul at Smyrna.

On the 12th of May, 1707, an island began to rise up, a musket-shot distant from the island of Sant-Erini, which continually increasing from day to day in the same manner, and troubling the sea, there rose up several rocks, that fixed themselves to this island; so that now, June 21., it is about half a mile in circumference.

Constantinople, Jan. 4. 1708. — They write from the island of Sant-Erini, in the Archipelago, about 28 leagues north of the town of Candia, that there lately sprung up from the bottom of the sea an island, formed of stones cast up by a volcano, which has often produced the same effects, and after the same manner. In the year 726, in the time of the Emperor Leo Isauricus, an island was formed on the north side, called the Burnt Island, by matter thrown up and heaped together by this volcano. In 1427, in the month of December, this Burnt Island was increased by huge rocks cast up by subterraneous fires. In 1650, in the month of September, the volcano again took fire, and produced the same effects, without forming any island, but only a shelf or bank 10 fathoms under water. Lastly, in the month of November last, 1707, the volcano made an island, which is already two miles in circumference, and still increases by rocks and other new matter thrown up. This burning was preceded, as at all other times, by violent shakings of the earth, followed by a thick smoke, that rose out of the sea in the day-time, and by flames in the night, and accompanied with a terrible roaring under ground. There is no instance of the effects of any volcano at land, like these in the sea; and yet what renders them the more

credible, is, that the island of Sant-Erini itself is almost all of it composed of burnt rocks and pumice-stones: it produces some sorts of grain, but has neither rivers nor springs, nor any other water but what is saved in cisterns.

Microscopical Observations on the Tongue and Taste. By Mr. ANTHONY VAN LEUWENHOEK.

HAVING taken some neats' tongues, and separated some thin parts of the outer skin, where I conceive is the place that admits the juices into the tongue, by which that sensation is produced which we call the taste, I separated those aforesaid external particles as well as I could from those that lay under them, and observed that the latter, that is, the internal, were furnished with a multitude of pointed particles, the tops of which were mostly broken off, and remained sticking in the outer skin: and one of those internal particles of the tongue, before a microscope, appeared as a transparent body, something larger than a thimble, having small internal holes or cavities, through which a greater quantity of light was admitted than by the other parts; and it seemed that the extreme parts of those cavities had exceedingly small orifices in them. On viewing with a microscope that space of the tongue which is between the protuberances, it was all over covered with abundance of exceedingly small rising round particles, so close to each other, that you could not put in two hairs between them. I stripped off also the surface of the tongue with a sharp knife, and repeated the same a second time, and then discovered an unspeakable number of small holes, some of which seemed to be filled, others were cut through lengthwise. From this appearance I inferred, that when we press our tongues against the roof of the mouth, in order to taste any thing, the said long particles, the ends of which are exceedingly slender, press through the uppermost skin, which at that place is also very thin, and endued with small pores or holes, and so receives a little juice; from all which proceeds the kind of sensation which we call taste.

I had often thought that our taste proceeds alone from the tongue, but within these few days I am become of another opinion; for when I viewed that part of the roof of the mouth, opposite to the top of the throat, where the notched or jagged parts of the tongue are determined, I judged that to be the place from whence the head partly discharges itself, and the matter to be cast out, which comes into the

mouth without its proceeding from the lungs; as also that there are a great many parts in it, which receive the matter which we call the taste

I took a cow or ox's head, and cut out the roof or palate, close to the throat, while yet warm; and pressing it gently, I could perceive issue out of several parts of it, small, round, protuberant, transparent drops; and pressing it a little harder, there ensued a yellow moisture. I took the uppermost skin of the said part, and viewing it through a microscope, I observed, that at most of the places from which the said liquor proceeded, there was a round ring or circle, of rather a darker colour than the skin or membrane that lay next it; I could also perceive in some of the said places, out of which the liquor came, that there were small holes or orifices, and these moist places were not all at equal distance from each other.

I discovered, also, in the said skin or membrane, a vast number of exceedingly small protuberances; as also in the uppermost thin skin, holes so very small, that they almost escaped the view through a microscope. On viewing the rough skin that lay under the thin skin, I perceived such slender fibres or bristles, of a darkish colour, that passed straight through the said skin, corresponding with the small protuberances and little holes, discovered in the uppermost skin. From this observation I imagined, that the last-mentioned holes or orifices, and the little fibres which I saw in the thick rough part, were those long particles that receive the juices, and which also produce that sensation called taste.

I also discovered several long slender pointed particles, which I conceived to be rooted or planted in the skin with a pointed end, and that these caused the afore-mentioned protuberances. And as these pointed parts, which were fixed in the said protuberances, were opposed to the sight with the points uppermost, one could not easily make any observation of them.

I was desirous to search into the inward parts of the nostrils of an ox, as well as I was able, with a view to the organs of smell; in doing which, I saw that each side of the mouth, which one might call the lips, was furnished with a great many pointed parts, that were very thick in the inner skin, and being round ran into a very slender point. I likewise observed the skins of several of the said parts, which were very strongly united to the parts that lay in it; and found that one of those parts that lay within, consisted of a great many pointed particles, which were much thicker and

longer than those I had discovered in the inward parts of the tongue.

The new Island thrown up near the Island of Santerini: By Mons. BOURGIGNON.

ON Monday the 23d of May, 1707, at sun-rising, we observed between the two Burnt Islands, commonly called the Little and Great Cameny, as it were a floating rock; which we thought at first had been some vessel shipwrecked on that coast, and seemed as if it would in a little time be dashed to pieces against the Lesser Cameny, that was hard by; on which account some mariners, in hopes of booty, put out immediately to view it. Soon after we were surprised to hear by them, that it was a shoal, which began to spring up from the bottom of the sea, and was not as yet very plainly to be discerned. Next day several persons went out of curiosity to satisfy themselves. Some of them went upon this new shoal, which was still moving, and sensibly increased under their feet. They brought back several curiosities, and among others a kind of oysters, very large, and of an exquisite taste, which they found sticking to the rock, and raised out of the water, as the shoal had increased in height; also a remarkable fine pumice-stone.

Two days before the springing up of this shoal there was an earthquake over the whole island; and this was the only trouble and fear that this new island gave us; for from its first appearance to the 13th or 14th of June it has continually increased very sensibly, both in extent and height, being now about half a mile in circuit, and from 20 to 25 feet high. This shoal is very pleasant to the view, being of a white colour, and round figure. The earth composing it is light, with a small mixture of clay. The sea appears now more and more troubled every day; not so much by this shoal lately removed, and still floating, as on account of the mixture of a vast quantity of different matters, continually thrown up night and day from the bottom of the sea; so that one might easily distinguish several sorts of minerals, by the diversity of colours they made on the surface of the water; but sulphur was in the greatest abundance, insomuch that the sea was coloured with it about Santerini, to near 20 miles' distance. The excessive rolling of the waves about the new shoal was greater than ever, and a more than ordinary heat was sensible to any one that approached too near, which was doubtless the cause of such quantities of fish being found dead on the shore.

There was perceived a noisome stench, that infected the neighbouring air, and which we, at more than three miles' distance, often found of dangerous consequence. The boiling of the waters grew every day considerably greater; and on Friday, July 16., at sunset, there was perceived, between this new island and the Lesser Cameny, as it were a chain of black rocks, that rose up from a prodigious depth of the sea, to the number of 17 or 18, not very distinct from each other, but seemed as if they would shortly unite together, and join themselves to this new island, as they actually did some few days after. Next day we saw them plainer, and those whose tops we could only see the night before, now appeared extraordinarily large. On Sunday we first perceived smoke to break out, much resembling in thickness and colour that of a burning furnace, and at the same time heard certain murmurings under ground, which seemed to proceed from the centre of this new island, as yet too deep in the sea, to be plainly distinguished.

Whole families went for refuge to the neighbouring islands, and others contented themselves only with changing their habitations, and living in the open country, thinking themselves safer there. In the mean time the rocks above mentioned united together, and seemed already to form another island, distinct from the former. The smoke appeared in greater abundance, and the fire which we so much dreaded at last began to break out about the 19th of July, at first small, but gradually increased. It was no less frightful and amazing than curious, to see every night on the top of this mount that nature had lately formed a vast number, as it were, of burning furnaces, all of a bright flame. One night, at the end of July, about an hour after sunset, as we were observing the different phenomena of this new island, there suddenly appeared in the middle region of the sky a fiery lance, seeming to come from east to west; but disappearing again soon, we could not exactly observe its dimensions. In the mean time the Burnt Island increased prodigiously, and extended itself principally on the south and north sides; the sea also seemed much more disturbed and loaded with sulphur and vitriol: the boiling of the water was more fierce and violent; the smoke thicker, and in greater abundance; and the fire larger and more frightful. But above all, a stench that infected the whole country grew so insupportable, that persons of the strongest constitutions could scarcely breathe in it; others, that were weaker, fell into frequent faintings; and almost every body was seized with vomitings. I could

not then but imagine myself on board some man of war, where, at a general discharge of all the guns, the confused stink of the powder, tar, and stench of the ship, especially in foul weather, often overcomes the strongest seamen. Just such a nauseous stench we were forced to breathe in, without being able anywise to avoid it, or defend ourselves from it. This ill scent was very mischievous, it spoiled most of the vines; and a great smoke that rose out of the midst of this new island like a mountain, uniting to a thick fog, that commonly hangs over Santerini when the wind is at south, burnt and destroyed, in the beginning of August, in less than three hours' time, all the fruit that was ripe and ready to be gathered, especially in such vineyards as lay most exposed to the south.'

Every night nature represented a great variety of scenes as the fire broke forth in different forms; sometimes burning ashes spread themselves in the air, like a plume of feathers, which falling again on the shoal, made it appear all of a light fire. At other times one would think it was the discharging of so many mortar-pieces, which threw up rocks, like so many bombs, capable of destroying the largest ships; though for the most part these stones were of a middle size, but in such quantities, that I often saw this little island all covered with them, and so pleasantly illuminated, that one would never be weary of looking on it.

These dreadful discharges were less frequent at the end of August, but increased in September, were daily in October and at this time (November 20.) are almost incessant; the island being now at least three miles in circumference, and from 35 to 40 feet in height. It is true, the noise is not so loud; the stones, that are cast up, are not so large nor so many; the boiling and disorder of the water is much abated; the sea begins to recover its former colour; the stench, that was before insupportable, has been very little for these six weeks. Yet the smoke grows every day thicker, blacker, and in greater abundance; the fire is more than ever, and seems sometimes to strike the very sky; the subterraneous noise is continual, and so violent that it cannot be distinguished from thunder; dust and ashes fall daily on this our island. In short, our new island grows every day more curious, more dreadful, and less accessible; and is continually increasing on the south-west side.

Concerning a Colliery that was blown up near Newcastle. By the Rev. Dr. ARTHUR CHARLETT.

ON Wednesday, the 18th day of August, 1708, at Fatfield, in the parish of Chester-le-street, about three o'clock in the morning, by the sudden eruption of a violent fire, which discharged itself at the mouths of three pits, with as great a noise as the firing of cannon, or the loudest claps of thunder, 69 persons were destroyed in an instant. Three of them, viz. two men and a woman, were blown quite up from the bottom of the shaft, 57 fathom deep, into the air, to a considerable distance from the mouth of the pit; one of the men with his head almost off, and the woman with her bowels hanging about her heels. The machine by which the coals were drawn up, and is of a great weight, was blown off by the force of the blast; and what is more wonderful, the fish which were in the rivulet, that runs 20 yards under the level, and at as great a distance from the mouth of one of the pits, were in great numbers taken up dead, floating on the water, by several of the inhabitants.

Concerning the Icy Mountains of Switzerland. By WILLIAM BURNET, *Esq.*

I WENT to the Grindlewald, a mountain two days' journey from Bern, where I saw, between two mountains, a river of ice as it were, which divides into two branches, and in its way, from the top to the bottom of the mountains, swells into vast heaps, some larger than St. Paul's church; the original of which seems to have been this: the tops of these mountains are covered all the year with snow; this snow melts in the summer, and falls to the bottom, where the sun never reaches; there it is frozen, which happens more easily to melted snow than common water. Thus every year it has increased, till it has reached the very top. The reason why the water has always frozen, though the sun shines on the middle of the mountain, and higher, some part of the day, is that the melted water goes under the ice already formed, and there freezes, and so expanding itself raises the ice above it, and sometimes makes it crack so as to frighten the whole neighbourhood. And the reason plainly appears, because the upper surface being solid, cannot be dilated without making great chinks, and that with a terrible noise. They told me, on the place, that every seven years the mountain increases, and the next seven it decreases; but I doubt their observation

is not exact. If there be any foundation for it, it seems to be, that in the hottest summers it increases, and in the more moderate ones it decreases, there being then less melted snow.

riments on Metals, made with the Burning-Glass of the Duke of Orleans. By Mons. GEOFFROY, *F.R.S.*

THIS burning-glass is three feet in diameter, and it collects the rays of the sun at 10 feet distance, where it forms a focus of about three inches diameter, which is again contracted, by means of another glass lens, to an inch diameter, and consequently is rendered nine times as strong.

The experiments on iron were the following: — I placed in the focus of the burning-glass a piece of forged iron, of about a drachm weight; it became red-hot, and its surface was covered with a black matter, like pitch or tar. On withdrawing the iron out of the focus in this state, this matter fixes itself on the surface of the metal, and there forms a small skin, or very fine blackish scale, which is easily separated by striking upon it; and that part of the iron that was covered with this scale appears blacker than ordinary. This scale is some of the sulphureous part of the iron, which rises to the surface of the metal when ready to melt, and there remains for some time, before it exhales. It is plainly this sulphureous part that rises upon iron, and polished steel, when heated, and gives them all those different colours, from a yellow to a violet, a water colour, or a black. By continuing to hold this piece of iron on the charcoal, it entirely melts, and at the same time emits very bright sparks in great quantities, sometimes to more than a foot distance from the coal.

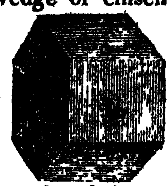
By saving what flies off during this sparkling, by holding a sheet of paper under the coal, we find that they are so many very small globules of iron, and the greatest part of them hollow. All the iron, that is held in fusion on the coal, flies away in sparkles after this manner, till none remains.

The result of these experiments is, that the four metals, which we call imperfect, viz. iron, copper, tin, and lead, are composed of a sulphur or oily substance, and of a metallic earth capable of vitrification: that from this sulphur proceeds the opacity, brightness, and malleability of a metal: that this metallic sulphur does not appear at all different from the oil of vegetables or of animals: that it is the same in mercury as in the four imperfect metals: that these four metals have for their basis an earth susceptible of vitrification:

that this earth is different in every one of these four metals, as it vitrifies differently in each of them; and that on this difference in vitrifying depends the difference of metals.

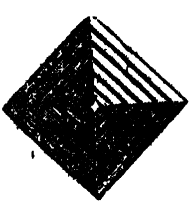
Microscopical Observations on the Particles of Crystallised Sugar. By M. Leuwenhoek, F.R.S.

The particles of sugar-candy consist of two broad and two narrow sides; and the others, *i. e.* the top and bottom, run into a sharp point, like the figure of a wedge or chisel. The following are some figures of them. The engraving represents a small bit of sugar-candy.



For my further satisfaction concerning sugar-candy, and its coagulation in syrup, I took some powdered sugar, and dissolved it in water, and then boiled it until I supposed all the water was evaporated; after which I placed it on several glasses, to observe the coagulation of its small particles. Some days after I observed a great many complete figures, which lay coagulated in several shapes, but all of them as clear and transparent as crystal, forming a pleasant sight: but I expected to have found them all of one and the same shape, and that they would have appeared like the above; but when viewed with a microscope, some of them appeared like this engraving.

I likewise saw a few coagulated sugar particles, that appeared in complete quadrilateral figures one of which is represented, and was as clear and transparent as any diamond. These particles were not larger than a small grain of sand. In the middle of them was a very clear particle, of the same figure with the whole body; from whence it appears, that the said whole body was much smaller at its coagulation, but increased continually by new accessions of matter round about it; and that in proportion to the number of perimeters, the body increased in size from time to time.



These particles preserved their complete forms and crystalline appearances as long as it was dry weather; but when it happened to be moist or rainy, we observed moisture about the particles of the sugar, which in dry weather evaporated again; and then there

coagulated an infinite number of small sugar particles upon the greater, and those were so exceedingly small, that a thousand of them together were not so large as one of those particles before represented, which was itself not so large as a single grain of sand. Now since we see that from one and the same matter two different figures are coagulated, it is easy to conceive that several other figures might be produced in the first coagulation, especially when any of the parts of those little bodies lie upon each other; and therefore, also, we should not wonder, to see, in the coagulation of salts, several figures produced out of one particle of salt.

On the Usefulness of the Silk of Spiders. By M. Bon, P.R.S. of Montpelier.

SPIDERS make a silk as beautiful, strong, and glossy, as common silk: the prejudice entertained against so common and despicable an insect is the reason that the public has been hitherto ignorant of its usefulness. Even common silk, as considerable as it is, was long unknown, and was neglected after its discovery. It was in the island of Coos, that Pamphila, daughter of Platis, first discovered the manner of working it. This discovery became soon after known to the Romans, who brought their silk from the country of the Seres, a people of Scythia in Asia, near the mountain Imaus, where silk-worms naturally breed; but far from deriving any advantage from so useful a discovery, they could never imagine these worms should produce so beautiful and valuable a thread, and made many chimerical conjectures about it. So that in consequence of their ignorance and idleness silk was for several ages so very scarce, that it was sold for its weight in gold; and Vopiscus relates, that for this reason the Emperor Aurelian refused his empress a suit of silks though she earnestly desired it. Its scarcity continued a long time, and it was to the monks at last that we owe the manner of breeding silk-worms, who brought their eggs from Greece, under the reign of the Emperor Justinian, as we learn from Godefridus, in his notes on the Code; and Ulpian assures us, that the price of silk was equal to that of pearls. It was late before France enjoyed the benefit of this discovery; when Henry II. brought to the marriages of his daughter and sister the first silk stockings that were seen in his kingdom. To him and his successors we owe the establishment of this manufacture at Tours and Lyons, which has made silk so

common, and has so greatly increased the magnificence of furniture and clothes.

The ingenious fable of Arachne shows us, that it is to the spider we owe the first hints of weaving cloth, and laying nets for animals; so the advantage which may arise from this insect will perhaps make it hereafter be esteemed as highly as silk-worms and bees.

I shall reduce all the different sorts of spiders to two principal kinds, viz. such as have long legs, and such as have short ones: the latter of which furnishes the silk I am now speaking of. In respect of their particular differences, they are distinguished by their colour; some being black, others brown, yellow, green, white; and some again of all these several colours mixed together. They differ also in the number and position of their eyes, some having six, others eight, and some ten, differently placed on the top of the head, as may easily be seen by the naked eye, but much better by the help of a glass. They are alike in other respects, as in their body, which nature has divided into two parts; the fore part is covered with a shell, or hard scale, set with hairs; it contains the head and breast, to which are fixed its eight legs, each of them consisting of six joints; they have also two other legs, which may be called their arms, and two claws, armed with two crooked nails, and joined by articulations to the extremity of the head; with these claws they kill the insects they feed on, their mouth being immediately underneath them. They have two small nails at the end of each leg, and a spongy substance between them, which is doubtless of service to them when they go upon smooth bodies.

All spiders spin their threads from the anus, about which there are five papillæ, or small nipples, which at first sight one would take for so many spindles, that serve to form the thread; I have found these papillæ to be muscular, and furnished with a sphincter. A little within these I have observed two others, from the middle of which issue several threads, in a pretty large quantity, sometimes more, and sometimes less, which the spiders make use of after a very mechanical manner, when they want to go from one place to another: they hang themselves perpendicular by a thread, and turning their head towards the wind, they shoot several others from their anus, like so many darts; and if by chance the wind, which spreads them abroad, fastens them to any solid body, which they perceive by the resistance they find in drawing them in from time to time with their feet, they

then make use of this kind of bridge, to pass to the place where their threads are fixed. But if these threads meet with nothing to fix on, the spiders continue to let them out further, till their great length, and the force with which the wind drives them, surpassing the weight of their bodies, they find themselves to be strongly drawn; and then breaking the first thread, which they hung by, they let themselves loose to be driven by the wind, and flutter on their backs in the air with their legs stretched out. And by these two ways it is, that they pass over roads, streets, and the broadest rivers, as in the engraving.

One may himself wind up these threads, which, by reason of their being united together, seem to be but one when they are about a foot in length; but I have distinguished them into 15 or 20 at their issuing from the anus. What is further remarkable, is the ease with which this insect moves its anus every way, by means of the many rings that border upon it. This is absolutely necessary for them, in order to wind up their threads or silk, which in the female spider is of two sorts. The first thread that they wind is weak, and serves them for no other use than to make that sort of web, in which they catch flies. The second is much stronger: in this they wrap up their eggs, and by this means preserve them from the cold, and secure them from such insects as would destroy them. These last threads are wrapped very loosely about their eggs, and resemble in form the bags of silk-worms, that have been prepared and loosened between the fingers, in order to be put upon the distaff.

These spiders' bags are of a grey colour when new, but turn blackish when long exposed to the air. It is true, one may find several other spiders' bags of different colours, and that afford a better silk, especially those of the tarantula; but their scarcity would render it very difficult to make experiments upon them; so that we must confine ourselves to the bags of such spiders as are most common, which are the short-legged ones. These always find out some place, secure from the wind and rain, to make their bags in; as hollow trees, the corners of windows or vaults, or under the eaves of houses. And by getting together a great many of these bags, it was that I made this new silk, which is nowise inferior in beauty to common silk. It easily takes all sorts of colours; and one can as well make large pieces of it as stockings and gloves, which I have done.

We could breed spiders as they do silk-worms; for they multiply much more, and every spider lays 600 or 700 eggs; whereas the papilios, or flies of silk-worms, lay only about 100; and of this number we must abate at least half, on account of their being subject to several diseases, and are so tender, that the least matter hinders them from making their bags. Spider-bags, on account of their lightness, yield much more silk than the others; as a proof of which, 13 oz. yield near 4 oz. of clean silk; 3 oz. of which will make a pair of stockings for the largest-sized man: those I have made weigh only 2 oz. and a quarter, and the gloves about three-quarters of an ounce; whereas stockings of common silk weigh 7 or 8 oz.

It is certain that a great advantage may be made of this insect, which has always been thought troublesome and dangerous, on account of its venom: but I confidently assert, that spiders are not venomous; having been very often bitten by them myself, without any ill consequence And as for their silk, it is so far from having any venom, that every body makes use of it to stop bleeding, and heal cuts; and, indeed, its natural gluten is a kind of balsam, that cures small wounds, by defending them from the air.

Experiments on Fishes kept in Water, under different Circumstances. By Mr. Fr. Hauksbee, F.R.S.

The fishes used in the following experiments were gudgeons; which are naturally very brisk and lively in the water, and can live a considerable time out of it. I put three into a glass vessel with about three pints of common water:

these fishes were to be a standard to compare the others by. Into another glass I put three more to a like quantity of water, which just filled it; I then screwed down a brass plate with a leather between, to prevent a communication with the water in the glass and the external air; and that it might the better resemble a pond of water frozen over, on which account this experiment was made, I suffered as little air as possible to remain on the surface of the included water. The third glass had a like quantity of water, which first by boiling, then by continuing it a whole night in vacuo on the air-pump, was completely deprived of its air: into this water, also, I put the same number of gudgeons as into the former, and then waited the event.

It was about half past ten o'clock in the morning when I began the experiments, and in about half an hour from that time, the fishes in the exhausted water, or water deprived of its air, began to discover some uneasiness by a more than ordinary motion in their mouths and gills, or respiration, if I may call it so, differing from the fishes in the other glasses, which at the same time showed no alteration: only I observed that they would now and then ascend to the top of the water, but suddenly swim down again; and in this state they continued for some considerable time, without any sensible alteration.

About five hours after the last observation, the fishes in the exhausted water became not so active, on a motion given to the glass that contained them, as before; and the gudgeons included without any communication with the outward air now began considerably to abate of their vivacity. At seven in the evening the included fishes lay all at the bottom of the glass, with their bellies upwards; nor on shaking the glass could I put them in motion, or cause them to stir their fins or tail, only I could observe a motion in their mouths, which showed they were not quite dead. In this state they lay for some time; but considering the experiment would not be complete, if I did not attempt their recovery by taking off the brass cover, being very certain they must have died in some small time under the circumstances they were in, I took off the cover, and gave the surface of the water a free and open communication with the external air. At about ten at night I observed them again, when their recovery was so evident, that on a little disturbing the glass that contained them, they were actually in motion again; and at this time, also, the fishes in the water deprived of air began to appear more brisk and lively than at the last observation.

Here I cannot but take notice, that though the water was

deprived of its air to a very great degree, yet the fishes put into it did not so much as once ascend in it; but continued always at the bottom, as those did in the common water. At this time I left them till the next morning; when, about eight o'clock, I found them as lively in all the glasses as when first put in.

From the whole account I observe, 1st, That water deprived of air, so far as the method here made use of is capable to do it, renders it not altogether unfit to support the lives of water animals. For though when the fish were first put in, and for some hours after, they seemed to suffer some uneasiness, yet, at length the water became more familiar to them, or their constitutions in some measure did so conform, as to render the water to them, and them to the water, more agreeable: otherwise I do not see how their recovery should follow, since on examination little or no alteration could be found in the circumstances of the water, from the time the fish were first put in.

2dly, The fish included with their water from any communication with the external air plainly demonstrate, that common water in its natural state is not, alone, sufficient to preserve the lives of its natural animals. Hence it follows, that in ponds, when the water comes to be frozen over with a pretty thick ice, the fish in such ponds are very likely, if not certain, to perish on the continuance of such a congelation for some time on their surfaces; unless (as in the latter part of the experiments) the impediment, which hindered the immediate contact of the air with the surface of the water, be removed; that is, by breaking holes in the ice, by which it is restored, and undoubtedly will perform the same thing as my removal of the brass plate. This is to be understood only in ponds, where the water is stagnant; for where there are springs, or a current of water constantly succeeding under the ice, the effect most likely will not be the same.

A Burning Spring at Broseley, in Shropshire. By Mr. Rd. Hopton.

The famous boiling well at Broseley, near Wenlock, in the county of Salop, was discovered about June, 1711. It was first announced by a terrible noise in the night, about two nights after a remarkable day of thunder: the noise awaked several people in their beds, that lived hard by; who coming to a boggy place under a little hill, about 200 yards from the river Severn, perceived a surprising rumbling and shaking in

the earth, and a little boiling up of water through the grass. They took a spade, and digging up some part of the earth, immediately the water flew up a great height, and a candle that was in their hand set it on fire. To prevent the spring being destroyed, an iron cistern is placed about it, with a cover to be locked, and a hole in the middle, through which the water may be viewed. If a lighted candle, or any thing of fire be put to this hole, the water immediately takes fire, and burns like spirit of wine, or brandy, and continues so long as the air is kept from it; but by taking up the cover of the cistern, it quickly goes out. The heat of this fire much exceeds the heat of any fire I ever saw, and seems to have more than ordinary fierceness in it.

Some people out of curiosity, after they have set the water on fire, have put a kettle of water over the cistern, and in it green peas, or a joint of meat, and cooked it much sooner than over any artificial fire that can be made. If there be put green boughs, or any thing else that will burn, upon it, it presently consumes them to ashes. The water of itself is as cold as any water I ever felt; and what is remarkable, as soon as ever the fire is out, if the hand be put into it, it feels as cold as if there had been no such thing as fire near it.

Observations on the Subterraneous Trees in Dagenham, and other Marshes, bordering on the River Thames. By the Rev. Mr. W. Derham, F.R.S.

Between four and five years ago, there happened an inundation at Dagenham and Havering marshes, in Essex, by a breach in the Thames wall, at an extraordinarily high tide; and by means of the great violence of the water, a large channel was torn up, or passage for the water, of 100 yards wide, and 20 feet deep in some places; in some more, some less. By which means a great number of trees were laid bare.

The trees were all of one sort, excepting only one, which was a large oak, with the greatest part of its bark on, and some of its head and roots. The rest of the trees are by most persons taken to be yew; but a very ingenious gentleman convinced me they might more probably be some other wood, as alder, which grows plentifully by our fresh-water brooks, or else hornbeam.

By lying so long under ground, the trees are become black and hard, and their fibres are so tough, that one may as easily break a wire of the same size as any of them.

They maintain this toughness, if the wood be kept dry. But by drying, the trees become cracked, and very flawy within, but look sound outwardly, and with difficulty yield to wedges.

There is no doubt but those trees grew in the place where they now lie, and that in vast multitudes, as they lie so thick upon, or near each other, that in many places I could step from one to another. And there is great reason to think, that not only the marshes, which are now overflown, which are about 1000 acres, are stored with those subterraneous trees, but also all the marshes along by the river side, for several miles: for we discover these trees all along the Thames side, over against Rainham, Wennington, Purfleet, and other places; and in the breach that happened at West-Thorrock, about 21 years ago, they were washed out in as great numbers and of the same kind of wood, as those found lately in Dagenham and Havering Levels.

Most of the trees that I met with had their roots on, and many of them their boughs, and some a part of their bark. There was only one that I perceived had any signs of the axe, and its head had been lopped off. As I passed the channel which the water had torn up, I could see all along the shores vast numbers of the stumps of those subterraneous trees, remaining in the very same posture in which they grew, with their roots running, some down, some branching and spreading about in the earth, as trees growing in the earth commonly do. Some of those stumps I thought had signs of the axe, and most of them were flat at top, as if cut off at the surface of the earth; but being rotten, and battered, I could not fully satisfy myself, whether the trees had been cut or broken off.

The soil in which all those trees grew was a black, oozy earth, full of the roots of reed; on the surface of which oozy earth the trees lay prostrate, and over them a covering of grey mould, of the same colour and consistence with the dry sediment, or mud, which the water leaves behind it at this day. This covering of grey earth is about seven or eight feet thick, in some places 12 feet or more, in some less; at which depths the trees generally lie. The trees lay in no kind of order, but some this way, some that, and many of them across: only in one or two places, I observed they lay more orderly, with their heads for the most part towards the north, as if they had been blown down by a southerly wind, which exerts great force on that shore.

Strata of Earth, Stone, Coal, &c. found in a Coal-Pit at the West End of Dudley, in Staffordshire. By Mr. BELLERS.

1. A yellowish clay, immediately under the turf.

2. A bluish clay.

3. A bluish hard clay, called by the miners clunch. This is one of the certain signs of coal. It has in it mineral plants.

4. A bluish soft clay.

5. A fine-grained grey stone; it lies next the former, and is found in some pits only.

6. A clay almost like the first, only whiter.

7. A hard grey rock, with something like the impressions of vegetables, but none distinct.

8. A blue clunch, like No. 3., with mineral plants in it. 8, +, this stratum, which is the same with No. 13., was not taken.

9. Coal, called bench-coal.

10. Coal, less black and shining than the former, called slipper-coal.

11. Coal, more black and shining, called spin-coal.

12. A coal, like cannal-coal, by the miners called stone-coal. These strata of coal have between each of them a bat, of about the thickness of a crown piece.

13. A black substance, called the dun-row-bat.

14. A hard grey iron-ore, called the dun-row-iron-stone.

15. A bluish bat, in which the following iron-stone lies, called the white-row.

16. A hard blackish iron-ore, lying in small nodules, having between them a white substance, and from thence by the miners called the white-row-grains, or iron-stone.

17. A hard grey iron-ore, with some white spots in it, called the mid-row-grains.

18. A black fissile substance, called the gublin-bat.

19. A hard blackish iron-ore, with white spots in it, called the gublin-iron-stone.

20. A bat, in substance much like that of No. 18.

21. A hard grey iron ore, called the cannoc, or cannot-iron-stone.

22. A bat, somewhat harder than No. 20.

23. A dark, grey, hard iron-ore, called the rubble-iron-stone.

24. The table-bat, next under the rubble-iron-stone.

25. A coarse sort of coal, called the foot-coal.

26. A black, brittle, shining bat.

27. The heathen-coal.

28. A substance like a coarse coal, but by the miners called a bat; perhaps because it does not burn well.

29. The bench-coal.

30. A bat under the last, and is as low, viz. 188½ feet, as they generally dig, though there is a coarse coal under this.

Some further Microscopical Observations on the Animalcula found on Duck-weed, &c. By Mr. LEUWENHOEK.

THE latter end of July, and beginning of August, I caused some of those green weeds, commonly called duck-weed, to be taken out of the water, that runs with a gentle stream through the town (Delft), for the pleasure of observing these animalcula, with others of several sorts, that were fastened to the duck-weed, or ran about upon it. Among others, I have found some animalcula, whose sheaths, at the extreme part, were a little thicker than a head hair, and composed of small globules, which were very easy to be distinguished.

I viewed one of these animalcula a good while together, and observed several times, one after another, that when the animalculum thrusts its body out of the sheath, or case, and that the wheel-like or indented particles moved in a circle, at the same time, out of a clear and transparent place, a little round particle appeared, which, without nicely viewing, could hardly be perceived; which particle growing larger, moved with great swiftness, as it were, about its own axis, and continued without any alteration in its place, till the animalculum had drawn part of its body back into its sheath; in doing which, it placed the said round particle on the edge of its sheath, which thus became augmented with a round globule: and whereas the animalculum had placed the said globule on the east part of its sheath, another time it fixed it on the south or north side; by which means the sheath was regularly increased on all sides.

Having further, and with great exactness, viewed the circulating indented wheel-work, I observed that it caused an exceedingly great motion in the water about it; by which means many very small particles, which were only visible through the microscope, were wafted to the said animalculum, and others were driven away. The animalculum made use of some of these particles, that were thus drawn to it by its circulating instrument, for food and nourishment; and other particles that were thus drawn to it were with great nimbleness driven away, and as if rejected by the animalculum: from whence I inferred, that those particles which were thus

thrust away, were not proper for its food. From this discovery we may conclude, that since this kind of animalculum cannot move from place to place in the water, nor consequently pursue its food, as other creatures do, that are endued with motion, being fastened by the tail or other parts of the body, it must necessarily be provided with such instruments as are fit to move the water, and by that means come at the particles floating in it, which serve for the nourishment, increase, and defence of its body.

I likewise observed a very few animalcula, whose bodies were short and thick, and much larger than those other animalcula that lodged themselves in a sheath, and were fastened by their tail, or extreme parts, to the little roots of the duck-weed; and though these short and thick animalcula could move from place to place, yet they also had a circular motion in the fore part of their bodies. From whence I concluded, that those motions served some other purposes than only to draw their food to them. On further considering what could be the use of these indented wheel-works, which are so like the indented wheels of a clock, or watch, I must own that they are very necessary to produce a great motion in the water; for, were it a round and smooth wheel, it would cause but a very small motion; whereas now, each tooth in the said wheel or circle produces a great motion, in comparison of what a smooth and plain wheel would do. Whence appears the surprising order in the formation of such small creatures, which are not to be perceived by the naked eye.

Concerning the Luminous Appearance observable in the Wake of Ships in the Indian Seas, &c. By FATHER BOURZES.

WHEN the ship ran apace, we often observed a [illegible] light in the wake, or the water that is broken and divi[illegible] the ship in its passage.

This light was not always equal: some days it was very little, others not at all; sometimes brighter, at others fainter; sometimes it was very vivid, and at other times nothing was to be seen. As to its brightness, I could easily read by it, though I was nine or ten feet above it from the surface of the water; that is, the title of my book, which was in large letters.

Not only the wake of a ship produces this light, but fishes also in swimming leave behind them a luminous track; which is so bright, that one may distinguish the size of the fish, and know of what species it is. I have sometimes seen a great

many fishes playing in the sea, which have made a kind of artificial fire in the water, that was a very pleasant sight. And often only a rope, placed crosswise, will so break the water, that it will become luminous. If one take some water out of the sea, and stir it ever so little with his hand in the dark, he may see in it an infinite number of bright particles. Or if one dip a piece of linen in sea-water, and twist or wring it in a dark place, he will see the same thing, and if it be even half dry.

The production of this light depends very much on the quality of the water; and, if I am not deceived, generally speaking, I may assert, other circumstances being equal, that the light is largest when the water is fattest and fullest of foam; for in the main sea the water is not every where equally pure; and sometimes linen dipped into the sea is clammy when it is drawn up again. And I have often observed, that when the wake of the ship was brightest, the water was more fat and glutinous; and linen moistened with it produced a great deal of light, if it were stirred or moved briskly.

Besides, in sailing over some places of the sea, we find a matter or substance of different colours, sometimes red, sometimes yellow. In looking at it, one would think it saw-dust; our sailors say it is the spawn or seed of whales. What it is, is not certain; but when we draw up water in passing over these places, it is always viscous and glutinous. Our mariners also say, that there are a great many heaps or banks of this spawn in the north; and that sometimes in the night they appear all over of a bright light, without being put in motion by any vessel or fish passing by them.

But to confirm further what I say, viz. that the water, the more glutinous it is, the more it is disposed to become luminous, I shall add one particular which I saw myself. One day we took in our ship a fish, which some thought was a boneta. The inside of the mouth of the fish appeared in the night like a burning coal; so that without any other light I could read by it the same characters that I read by the light in the wake of the ship. Its mouth being full of a viscous humour, we rubbed a piece of wood with it, which immediately became all over luminous; but as soon as the moisture was dried up, the light was extinguished.

An Account of a Woman who had lain six Days covered with Snow, without receiving any Nourishment, &c. By Mr. Samuel Bowdich.

Joanna Crippen, of Chardstock, in Dorset, being a spinner of worsted, was going home on the 24th of January with some work, but snow falling abundantly, and lying deep on the ground, she was forced to lie down under a hedge, having lost one of her shoes; and her clothes, which were very mean, were by the brambles and thorns torn almost off her back: in which place she lay from Monday evening about six o'clock, until Sunday following about four in the afternoon, and then was discovered by some of our neighbours, who went out with poles, shovels, &c. to search for her; and after some time spent in it, at last found her buried in four feet deep of snow. One of the men thrusting at her with his pole, found she was there, and alive. She immediately spoke, and begged he would not push her too hard, for she was almost naked; and desired that some of the women would come to her, and take her out, which was accordingly done; when they found her without stockings or shoes, an old whittle about her shoulders, with a large hole in it, which she had ate through: the snow melting down on her, she drank to quench her thirst. She had a mortification of one of her great toes, but she now is very hearty, and in a fair way of a perfect recovery. She was very sensible at the first taking her out, and still continued so; and she knew every body perfectly well: and yet she had taken no manner of food all the time of her being in the snow.

An Account of several extraordinary Meteors or Lights in the Sky. By Dr. Edmund Halley.

The theory of the air seems now to be perfectly well understood, and its different densities at all altitudes, both by reason and experiment, are sufficiently defined; for, supposing the same air to occupy spaces reciprocally proportional to the quantity of the superior or incumbent air, I have elsewhere proved, that at 40 miles high the air is rarer than at the surface of the earth about 3000 times; and that the utmost height of the atmosphere, which reflects light in the crepusculum, is not fully 45 miles.

That meteor which was seen in 1708, on the 31st of July, between 9 and 10 o'clock at night, was evidently between 40 and 50 miles perpendicularly high, and as near as I can gather,

over Sheerness and the buoy on the Nore. It appeared to move with an amazing velocity, darting, in a very few seconds of time, for about twelve degrees of a great circle from north to south, being very bright at its first appearance, and it died away at the end of its course, leaving for some time a pale whiteness in the place, with some remains of it in the track where it had gone; but no hissing sound, as it passed, or explosion were heard.

Like to this, but much more considerable, was that famous meteor which was seen to pass over Italy on the 21st of March O.S. anno 1676, about an hour and three quarters after sunset, which happened to be observed, and was well considered, by the famous professor of mathematics in Bononia, Geminian Montanari, as may be seen in his Italian treatise about it, soon after published at Bononia. He observes that at Bononia its greatest altitude in the S.S.E. was 38 degrees, and at Sienna 58 to the N N.W.: that its course, by the concurrence of all the observers, was from E.N.E. to W.S.W.: that it came over the Adriatic Sea as from Dalmatia: that it crossed over all Italy, being nearly vertical to Rimini and Savigniano on the one side, and to Leghorn on the other: that its perpendicular altitude was at least 38 miles: that in all places near this course, it was heard to make a hissing noise as it passed, like that of artificial fire-works: that having passed over Leghorn, it went off to sea towards Corsica; and, lastly, that at Leghorn it was heard to give a very loud report like a great cannon; immediately after which, another sort of sound was heard, like the rattling of a great cart running over stones. He concludes, from the apparent velocity it went with at Bononia, at above 50 miles distance, that it could not be less swift than 160 miles in a minute of time, which is above ten times as swift as the diurnal rotation of the earth under the equinoctial, and not many times less than that with which the annual motion of the earth about the sun is performed. To this he adds its magnitude, which appeared at Bononia larger than the moon in one diameter, and above half as large again in the other; which, with the given distance of the eye, makes its real less diameter above half a mile, and the other in proportion. This supposed, it cannot be wondered that so great a body moving with such an amazing velocity through the air, though so much rarefied as it is in its upper regions, should occasion so loud a hissing noise, as to be heard at such a distance as it seems this was.

I have much considered this appearance, and think it one of the hardest things to account for that I have yet met with

in the phenomena of meteors, and am induced to think that it must be some collection of matter formed in the ether, as it were by some fortuitous concourse of atoms, and that the earth met with it as it passed along in its orb. For its direction was exactly opposite to that of the earth, which made an angle with the meridian at that time (the sun being in about 11 degrees of Aries) of 67°, that is, its course was from W.S.W. to E.N.E., so that the meteor seemed to move the contrary way. And besides, falling into the power of the earth's gravity, and losing its motion from the opposition of the medium, it seems that it descended towards the earth, and was extinguished in the Tyrrhene Sea, to the W.S.W. of Leghorn. The great report being heard on its first immersion into the water, and the rattling, like the driving a cart over stones, being what succeeded on its quenching; something like which is always observed on quenching a very hot iron in water.

On his own Philosophy. By Sir Isaac Newton.

The philosophy which Mr. Newton, in his Principles and Optics, has pursued, is experimental; and it is not the business of experimental philosophy to teach the causes of things, any further than they can be proved by experiments. We are not to fill this philosophy with opinions which cannot be proved by phenomena. In this philosophy, hypotheses have no place, unless as conjectures or questions proposed to be examined by experiments. For this reason, Mr. Newton in his Optics distinguished those things which were made certain by experiments, from those things which remained uncertain, and which he therefore proposed in the end of his Optics in the form of queries. For this reason, in the preface to his Principles, when he had mentioned the motions of the planets, comets, moon, and sea, as deduced in this book from gravity, he added, "I wish the other phenomena of nature could by the same way of reasoning be deduced from mechanical principles; for several things induce me to believe, that all these things may depend upon certain forces, by which the particles of bodies are, by causes still unknown to us, either mutually impelled towards each other, and cohere together according to certain regular configurations, or mutually recede from each other; and for want of knowing these forces philosophers have hitherto attempted to no purpose to explain nature." And in the end of this book, in the second edition, he said, that for want of a sufficient number of experiments, he forbore

to describe the laws of the actions of the spirit or agent by which this attraction is performed. And for the same reason he is silent about the cause of gravity, there occurring no experiments or phenomena by which he might prove what was the cause of it. And this he has abundantly declared in his Principles, near the beginning, in these words, "I do not enquire into the physical causes and seats of forces."

And a little after, "I indifferently and promiscuously use for each other the words attraction, impulse, or any kind of propension towards the centre, by considering these forces not physically but mathematically. Whence I would caution the reader not to think, that by these words I define the species or manner of the action, or the physical cause or reason; or that I truly and physically ascribe forces to centres, which are only mathematical points, if I should happen to say, *that either the centres attract, or that there are central forces*." And at the end of his Optics, "Here I do not enquire by what efficient cause these qualities, viz. gravity, the magnetic and electrical forces, are produced. What I call attraction may possibly be produced by impulse, or in some other manner unknown to us. By attraction, I would here be understood to mean only in general, *a certain kind of force, whereby bodies mutually tend towards each other, whatever cause that quality may be ascribed to.* For we must first necessarily know by phenomena of nature what bodies mutually attract each other, and what are the laws and properties of that attraction, before we can properly enquire by what efficient cause that attraction is produced." And a little after he mentions the same attractions as forces which by phenomena appear to have a being in nature, though their causes be not yet known; and distinguishes them from occult qualities, which are supposed to flow from the specific forms of things. And in the scholium at the end of his Principles, after he had mentioned the properties of gravity, he added, "But the reason of these properties of gravity I could not deduce from phenomena, and I do not devise hypotheses. For whatever is not deduced from phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, or of occult or mechanical qualities, have no place in experimental philosophy. It is sufficient that gravity really exists, and acts according to the laws I have explained, and that it solves all the motions of the celestial bodies and of our sea." And after all this, one would wonder that Mr. Newton should be reflected on, for not explaining the causes of gravity, and other attractions by

hypotheses; as if it were a crime to content himself with certainties, and let uncertainties alone.

An Account of a Journey from the Port of Oratava, in the Island of Teneriffe, to the Top of the Peak in that Island, in August, 1715; *with Observations. By Mr. J.* Edens.

Between La Stancha and the top of the Peak there are two very high mountains besides the Sugar-loaf, each of which mountains is almost half a mile's walking: on the first of them the rubbish is small, and we were apt to slip back as we stepped upwards. But the uppermost is all composed of hard loose rocky great stones, cast together in a very confused order. After resting several times, we came to the top of the first mountain, where we drank every one a little wine, and ate a bit of gingerbread. Then, being pretty well refreshed, we set forwards again to ascend the second mountain, which is higher than the first, but is better to walk on, because of the firmness of the rocks. After we had travelled for about half an hour up the second mountain, we came within sight of the Sugar-loaf, which before we could not see by reason of the interposition of these great hills. After we were arrived to the top of this second mountain, we came to a way that was almost level, but rather ascending; and about a furlong farther is the foot of the Sugar-loaf, which we soon reached. Then looking upon our watches, we found it to be just three o'clock. The night was clear where we were and the moon shone very bright; but below, over the sea, we could see the clouds, which looked like a valley at a prodigious depth below us We had a brisk air, the wind being S. E by S., as it was for the most part while we were on our journey.

While we sat at the foot of the Sugar-loaf, resting and refreshing ourselves, as before in other places, we saw the smoke break out in several places, which at first looked like little clouds, but they soon vanished; others not long after succeeding them, from the same or other places. We set forwards to ascend the last and steepest part of our journey, viz. the Sugar-loaf, exactly at half past three, and after we had rested twice or thrice, we all arrived there by four.

The shape of the top of the Peak is partly oval, the longest diameter lying N.N.W. and S.S.E., and is, as near as I could guess, about 140 yards long; the breadth the other way being about 110. Within the top of the Peak is a very deep hole, called the Caldera, or Kettle, the deepest part of which

lies at the south end: it is, I believe, 40 yards deep, reckoning from the highest side of the Peak; but it is much shallower reckoning from the side opposite to Garachica. The sides of this kettle are very steep, in some places as steep as the descent on the outside of the Sugar-loaf. We all went to the bottom of this kettle, where a great many very large stones lie, some of them above six feet in height. The earth that is within-side the kettle being rolled up long and put to a candle, will burn like brimstone. Several places within-side the top of the Peak are burning, as on the outside; and in some places, on turning up the stones, is found very fine brimstone or sulphur sticking to them. At the holes where the smoke comes out, there also comes forth a great heat, so hot that one cannot endure one's hand there long. At the N. by E. side, within the top, is a cave, where we found a dead goat; in which cave sometimes the true spirit of sulphur distils, as they say, but it did not drop while I was there.

The report is false about the difficulty of breathing upon the top of this place; for we breathed as well as if we had been below: we ate our breakfast there, and I was there in all for about two hours and a quarter. Before the sun rose I think the air was as cold as I have known it in England, in the sharpest frost I was ever in: I could scarcely endure my gloves off. There was a great dew all the while we were there till sun-rising, which we could find by the wetness of our clothes; but the sky looked there as clear as possible. A little after sun-rising we saw the shadow of the Peak on the sea, reaching over the island of Gomera; and the shadow of the upper part, viz. of the Sugar-loaf, we saw imprinted like another peak in the sky itself, which looked very surprising: but the air being cloudy below us, we saw none of the other islands, except Grand Canaria and Gomera.

A short History of the several New Stars that have appeared within these 150 *Years. By Dr* Halley.

Whether it be owing to the greater diligence of the moderns, or that in reality no such thing has happened for many ages past, I will not undertake to determine; but this is certain, that within the space of the last 150 years more discoveries have been made of changes among the fixed stars than in all antiquity before.

1st. That in the chair of Cassiopeia was not seen by Cornelius Gemma on the 8th of November, 1572, who says, he that night considered that part of heaven in a very serene

sky, and saw it not: but that the next night, November 9., it appeared with a splendour surpassing all the fixed stars, and scarcely less bright than Venus. This was not seen by Tycho Brahe before the 11th of the same month, but from thence he assures us that it gradually decreased and died away, so as in March, 1574, after 16 months, to be no longer visible; and at this day no signs of it remain.

Such another star was seen and observed by the scholars of Kepler, to begin to appear on Sept. 30., O. S. 1604, which was not to be seen the day before: but it broke out at once with a lustre surpassing that of Jupiter; and like the former it died away gradually, and in much about the same time disappeared totally, there remaining no traces of it in Jan. 1605–6.

But between them, viz. in the year 1596, we have the first account of the wonderful star in collo ceti, seen by David Fabricius on the third of August, O. S., as bright as a star of the third magnitude, which has been since found to appear and disappear periodically; its period being nearly seven revolutions in six years, though it returns not always with the same lustre. Nor is it ever totally extinguished, but may at all times be seen with a six-foot tube.

Another new star was first observed by Will. Jansonius, in the year 1600, in pectore, or rather in eductione colli cygni, which exceeded not the third magnitude. This having continued some years, became at length so small, as to be thought by some to disappear entirely: but in the years 1657, 1658, and 1659, it again rose to the third magnitude, though soon after it decayed by degrees to the fifth or sixth magnitude, and at this day is to be seen as such.

A fifth new star was first seen and observed by Hevelius, in the year 1670, on July 15. O.S., as a star of the third magnitude; but by the beginning of October it was hardly to be perceived by the naked eye. In April following it was again as bright as before, or rather greater than of the third magnitude, yet wholly disappeared about the middle of August. The next year, in March, 1672, it was seen again, but not exceeding the sixth magnitude: since then, it has been no further visible.

The sixth and last, is that discovered by Mr. G. Kirch, in the year 1686, and its period determined to be of 404½ days; and though it rarely exceeds the fifth magnitude, yet is it very regular in its returns, as we found in the year 1714. Since then, we have watched, as the absence of the moon and the clearness of weather would permit, to observe the

first beginning of its appearance in a six-foot tube, which bearing a very great aperture discovers most minute stars. And on June 15. last, it was first perceived like one of the very least telescopical stars: but in the rest of that month and July it gradually increased, so as to become in August visible to the naked eye; and so it continued all the month of September. After that it again died away by degrees, and on the eighth of December at night it was scarcely discernible by the tube, and as near as could be guessed, equal to what it was at its first appearance on June 15th; so that this year it has been seen in all near six months, which is but little less than half its period: and the middle, and, consequently, the greatest brightness, falls about the 10th of September.

An Account of some large Teeth lately dug up in the North of Ireland. By Mr. Francis Nevile.

Several large teeth were lately found within eight miles of Bulturbet, at a place called Maghery, in part of the Bishop of Killmore's lands, on digging the foundation for a mill near the side of a small brook, that parts the counties of Cavan and Monoghan.

There are in all four teeth, two of a larger and two of a smaller sort; the larger one is the farthest tooth in the under jaw; the other is like it, and belongs to the opposite side; the lesser tooth I take to be the third or fourth tooth from it, and has its fellow: these are all that were found, and one of them in a piece of the jaw-bone, which mouldered away as soon as taken out of the earth; there was part of the skull found also of a very large size and thickness, but as soon as exposed to the air, it mouldered away as the jaw had done.

Some few pieces of other bones were found, but none entire; yet by those bits that were found, one might guess that they were parts of those that were of a larger size.

The place where this monster lay was about four feet under ground, with a little rising above the superficies of the earth, which was a plain under the foot of a hill, and about 30 yards from the brook. The bed on which it lay had been laid with fern, with that sort of rushes here called sprits, and with bushes intermixed, and nut-shells. The branches of the fern, in every lay as we opened them, were very distinguishable, as were the seeds of the rushes and the tops of boughs.

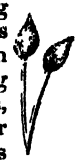
The two large teeth are of equal weight, 2¾ lb. each; the

two small teeth are six ounces each; but some of them are wasted, and some roots that enter the jaw broken off.

Having examined the four teeth, I am fully convinced, and can on sure grounds affirm, that they must certainly have been the four grinding teeth in the lower jaw of an elephant: and that the many loose fragments of bones that were found with them must have been remains of the same animal.

Some Microscopical Observations on the Substance of a Melon. By M. Leuwenhoek.

Having kept a cut melon four days, I found several of mouldiness on the fleshy or pulpy part of the fruit, somewhat green towards the rind; and of a paler colour towards the middle of the fruit. These spots grew larger every hour for the space of five days; at which time the whole fruit was quite covered over. This surprising vegetation made me curious to examine if there was any difference between those parts which were green and the others, besides their colour. The first, being seen with the microscope, appeared to be a fungus, whose cap was filled with little seeds, to the number of about 500; which shed themselves in two minutes after they had been in the glasses.



The other sort had many grass-like leaves, among which appeared some stalks with fruit on their top. Each plant might well enough be compared to a sort of bull-rush. They had their seed in great quantities, which I believe were not longer than three hours before they began to vegetate; and it was about six hours more before the plants were wholly perfected: for, about seven o'clock one morning, I found three plants at some distance from any others; and about four the same day, I could discern above 500 more growing in a cluster with them, which I supposed were seedling-plants of that day. The seed of all these were then ripe and falling.

When the whole fruit had been thus covered with mould for six days, this vegetable quality began to abate, and was entirely gone in two days more. Then was the fruit putrefied, and its fleshy parts now yielded no more than a stinking water, which began to have a gentle motion on its surface, that continued for two days without any other appearance. I found then several small maggots to move in it, which grew for the space of six days; after which they laid themselves up in their bags.

Thus they remained for two days more without motion, and then came forth in the shape of flies. The water at that time was all gone, and there remained no more of the fruit than the seeds, the vessels which composed the tunics of the ovaries, the outward rind, and the excrement of the maggots; all which together weighed about an ounce. So that there was lost of the first weight of the fruit when it was cut above 20 ounces.

The Art of Living under Water. By Edm. Halley. *LL.D. Secretary to the Royal Society.*

The divers for sponges in the Archipelago help themselves, by carrying down sponges dipped in oil in their mouths: but considering how small a quantity of air can be supposed to be contained in the pores or interstices of a sponge, and how much that little will be contracted by the pressure of the incumbent water, it cannot be believed that a supply obtained by this means can long support a diver: since by experiment it is found that a gallon of air, included in a bladder and by a pipe, reciprocally inspired and expired by the lungs of a man, will become unfit for any further respiration, in little more than one minute of time; and though its elasticity be but little altered, yet in passing the lungs, it loses its vivifying spirit, and is rendered effete, not unlike the medium found in damps, which is present death to those that breathe it; and which in an instant extinguishes the brightest flame, or the shining of glowing coals or red-hot iron, if put into it.

When, therefore, there has been occasion to continue long at the bottom, some have contrived double flexible pipes, to circulate air down into a cavity inclosing the diver as with armour, to bear off this pressure of the water, and to give leave to his breast to dilate on inspiration: the fresh air being forced down by one of the pipes with bellows or otherwise, and returning by the other; not unlike an artery and vein. This has indeed been found sufficient for small depths, not exceeding 12 or 15 feet: but when the depth surpasses three fathoms, experience teaches us that this method is impracticable.

To remedy these inconveniences, the diving-bell was next thought of; in which the diver is safely conveyed to any reasonable depth, and may stay more or less time under water according as the bell is of greater or less capacity. This is most conveniently made in form of a truncated cone, the smaller basis being closed, and the larger open; and

ought to be so poised with lead, and so suspended, that the vessel may sink full of air, with its greater or open basis downwards, and as near as may be in a situation parallel to the horizon, so as to close with the surface of the water all at once. Under this receptacle the diver sitting, sinks down together with the included air to the depth desired; and if the cavity of the vessel will contain a tun of water, a single man may remain in it at least an hour, without much inconvenience, at five or six fathoms deep.

Being engaged in an affair that required the skill of continuing under water, I found it necessary to obviate these difficulties, which attend the use of the common diving-bell, by inventing some means to convey air down to it, while below; by which not only the included air would be refreshed and recruited, but also the water wholly driven out, in whatever depth it was. This I effected by a contrivance so easy, that it may be wondered it should not have been thought of sooner, and capable of furnishing air at the bottom of the sea in any quantity desired. The description of my apparatus is as follows: —

The bell I used was of wood, containing about 60 cubic feet in its concavity, and was of the form of a truncated cone, the top diameter three feet, and the bottom five. This I coated with lead so heavy that it would sink empty, and I distributed the weight so about its bottom, that it would go down only in a perpendicular situation. In the top I fixed a strong clear glass, as a window to let in the light from above; and likewise a cock to let out the hot air that had been breathed; and below, about a yard under the bell, I placed a stage which hung by three ropes, each of which was charged with about a hundred weight, to keep it steady. This machine I suspended from the mast of a ship, by a sprit, which was sufficiently secured by stays to the mast-head, and was directed by braces to carry it overboard clear of the ship-side, and to bring it again withinboard as occasion required.

To supply air to this bell, when under water, I caused a couple of barrels, of about 36 gallons each, to be cased with lead, so as to sink empty; each having a bung-hole in its lowest part to let in the water, as the air in them condensed on their descent; and to let it out again, when they were drawn up full from below. And to a hole in the upper part of these barrels I fixed a leather trunk or hose, well liquored with bees' wax and oil, and long enough to fall below the bung-hole, being kept down by an appended weight; so

that the air in the upper part of the barrels could not escape, unless the lower ends of these hose were first lifted up.

The air-barrels being thus prepared, I fitted them with tackle proper to make them rise and fall alternately, after the manner of two buckets in a well; which was done with so much ease, that two men, with less than half their strength, could perform all the labour required: and in their descent they were directed by lines fastened to the under edge of the bell, which passed through rings placed on both sides of the leather hose in each barrel; so that sliding down by those lines, they came readily to the hand of a man, who stood on the stage on purpose to receive them, and to take up the ends of the hose into the bell. Through these hose, as soon as their ends came above the surface of the water in the barrels, all the air that was included in the upper parts of them was blown with great force into the bell, while the water entered at the bung-holes below, and filled them: and as soon as the air of the one barrel had been thus received, on a signal given, that was drawn up, and at the same time the other descended; and by an alternate succession furnished air so quick, and in so great plenty, that I myself have been one of five who have been together at the bottom in nine or ten fathoms water, for above an hour and a half at a time, without any sort of ill consequence; and I might have continued there as long as I pleased, for any thing that appeared to the contrary. Besides, the whole cavity of the bell was kept entirely free from water, so that I sat on a bench, which was diametrically placed near the bottom, wholly dressed with all my clothes on. I only observed, that it was necessary to be let down gradually at first, as about 12 feet at a time; and then to stop and drive out the water that entered, by receiving three or four barrels of fresh air, before I descended further. But being arrived at the depth designed, I then let out as much of the hot air, that had been breathed, as each barrel would replenish with cool, by means of the cock at the top of the bell; through whose aperture, though very small, the air would rush with so much violence, as to make the surface of the sea boil, and cover it with a white foam, notwithstanding the great weight of water over us.

Thus I found I could do any thing that was required to be done just under us; and that, by taking off the stage, I could, for a space as wide as the circuit of the bell, lay the bottom of the sea so far dry, as not to be over-shoes on it. And by the glass window so much light was transmitted, that when

the sea was clear, and especially when the sun shone, I could see perfectly well to write or read, much more to fasten or lay hold on any thing under us, to be taken up. And by the return of the air-barrels I often sent up orders, written with an iron pen on small plates of lead, directing how to move us from place to place as occasion required. At other times when the water was troubled and thick, it would be dark as night below; but in such case, I have been able to keep a candle burning in the bell as long as I pleased, notwithstanding the great expense of air requisite to maintain flame.

Concerning Britain having formerly been a Peninsula. By Dr. William Musgrave, F.R.S.

Supposing Britain to have been a peninsula, Dr. Musgrave proposes to examine, 1. Whether an isthmus or neck of land could not have been washed or worn away; and, 2. Whether that between Britain and France really was so.

In respect to the first question, he observes, 1. That remarkable ridge of land, in the strait itself, shows that the land there was formerly much higher; but being continually washed away by the tides, for some thousands of years, has been reduced to the state in which it is at this day; which will appear the more probable, if we consider, that it is a constant and infallible rule, that the more the bottom of the sea is worn or washed by its waters, the more level and even it becomes. 2. The steep white cliffs, consisting of chalk and flint, on the opposite shores of the straits, and answering to each other for six miles on each side, plainly show that they were formerly separated by washing away the intermediate earth. 3. The state and condition of that tract of land, called Romney-Marsh, agree very well with the supposition of an isthmus: for, while the isthmus remained, it must have been an obstacle to the tides; and, consequently, have caused the overflowing of Romney-Marsh, as being a plain low bottom; and that this marsh was formerly sea, appears from its strong bulwark. After the isthmus was broken through, and all obstacles removed, the sea retired from Romney-Marsh into its channel; whence what was formerly an estuary is now a fertile plain, 20 miles long and eight broad, and yielding very good pasture for cattle.

Lastly, Supposing that there was formerly an isthmus here, it is very easy to conceive how wolves, and other noxious animals, might come into Britain; whereas on the contrary

supposition it will be ridiculous to imagine that they were transported thither in ships, for the conservation of their species.

We must not allow that we have no hints of this event in history; for what is plainer than this passage in Virgil?

—— Penitus toto divisos orbe Britannos.

May we not suppose that the word divisos may import the rending or breaking off one thing from another? And that Virgil knew its signification very well, and was well acquainted with antiquity, and had not forgot himself? On these words Servius says, "Because Britain was formerly joined to the Continent:" than which nothing can be more plain, than that the breaking through of this isthmus was known to the ancients.

Therefore, from the whole the Doctor concludes, that Britain was not originally an island, but became such from a peninsula; and that, as is probable, by the concurrence of some one or other of the more boisterous winds with the tides, and so breaking through the isthmus.

An Account of an Experiment to show that all Places are not equally full. By J. T. Desaguliers, M.A. F.R.S.

We let fall a guinea, and two papers, in an air-pump, the one placed over, and the other under it, before any air was pumped out: the guinea came to the bottom when the papers were in the middle of the second glass from the top. Then having laid a feather on the brass springs close by the guinea, we let them loose both together; and the feather was fallen only down to the fourth part of the length of the first glass, or $\frac{1}{16}$ of the whole distance, when the guinea was got down to the bottom of the receiver. We then laid two papers and two feathers, one of each under, and the other over the guinea between the springs; and having drawn out so much of the air as to bring up the mercury in the gauge-tube, within a quarter of an inch of the greatest height to which it could be then raised by the pressure of the external air, we caused the bodies to fall all at once; and though the papers came down to the bottom at the same time as the guinea, yet the feathers, being much lighter, wanted about three inches. But at last, having laid the papers, feathers, and guinea, as before, we pumped out all the air, and then the feathers, as well as the papers, came to the bottom of the receiver at the same instant of time as the guinea

An Account of the Skeleton of a large Animal impressed on Stone. By Dr. WILLIAM STUKELY, *F.R.S.*

AT Elston, near Newark in Nottinghamshire, was discovered an almost entire skeleton of a large animal, impressed on a very hard blue clay stone; the same as, and undoubtedly came from, the neighbouring quarries about Fulbeck, on the western cliff of the long tract of hills extending quite through the adjacent county of Lincoln It lay, time out of mind, at the side of a well near the parsonage-house, where it had served for a landing-place to those that drew water; but on removal, the under-side exhibited this unusual form. Where the remaining part of the stone may be, which contained the upper part and continuation of the skeleton, is now utterly unknown. It seems to be that of a crocodile or porpoise. There are 16 vertebræ of the back and loins, very plain and distinct, with their processes and intermediate cartilages; nine whole or partial ribs of the left-side; the os sacrum, the ileum in situ, and two thigh-bones displaced a little; the beginnings of the tibia and fibula of the right leg; on one corner there seem to be the vestigia of a foot with four of the five toes, and a little way off an entire toe, now left perfect in the stone: there are no less than 11 joints of the tail, and the cartilages between them of a white colour distinguishable from the rest.

About six years since, I was shown many human bones taken from whole skeletons, with British beads, chains, iron rings, brass bits of bridles, and the like, which were dug up in a quarry at Blankney in Lincolnshire; which probably was plain mold when these old bodies of the Britons were interred; and since then I saw many human bones and armour, with Roman coins, fibulæ, &c. found in a stone pit in the park at Hunstanton in Norfolk, which were supposed to have been buried in the earth after a battle. Whence we may judge it a vulgar error, in the ruins of old castles and walls to admire the tenacity of the mortar, and to praise our ancestors for an art which we suppose now lost; when doubtless the strength of the cement is owing to length of time; and in future ages the same judgment may be formed of our modern buildings.

From all these instances, I infer the ancient state of these cliffs, where this skeleton was found, and shells are daily found, intimately mixed in the substance of the stone, to have formerly been of a softer consistence, capable of admitting them into its bowels, and immuring them as part of itself; and that earth which is now manageable by the plough, may

possibly, in time, assume the same density, at least not far below the surface; for in this very cliff the upper strata are still clay, becoming the harder the deeper.

Experiments made with Mons. Villette's Burning Concave. By the Rev. Dr. J. Harris, and Dr. J. T. Desaguliers.

This mirror is a concave, 47 inches wide, and ground to a sphere of 76 inches radius; so that its focus is about 38 inches distant from the vertex of the glass. The metal, of which it is made, is a mixture of copper, tin, and tin-glass, and its reflection has something of a yellow cast. The concave surface has scarcely any flaws, and those very small; but the convex side, which is also polished, has some holes in it.

Having held several bodies in the focus of this mirror, we observed what happened to them while exposed to this great heat; and with a half second pendulum noted the time in which any material change happened to them. The experiments were made from 9 till 12 in the morning, as follow: —

No. 1. A red piece of a Roman patera, which began to melt in three seconds was ready to drop in 100. 2. Another black piece melted at four, and was ready to drop in 64 seconds. 3. Chalk taken out of an echinus spatagus filled with chalk only fled away in 23 seconds 4. A fossil shell calcined in seven seconds, and did no more in 64. 5. A piece of Pompey's pillar at Alexandria was vitrified in the black part in 50 seconds, and in the white part in 54. 6. Copper ore, which had no metal in it visible, vitrified in eight seconds. 7. Slag, or cinder of the ancient iron-work said to have been wrought by the Saxons, was ready to run in 29½ seconds

Here the glass, growing hot, burned with much less force.

8. Iron-ore fled at first, but melted in 24 seconds. 9. Talc began to calcine at 40 seconds, and held in the focus 64. 10. Calculus humanus in two seconds was calcined, and only dropped off in 60. 11. An anonymous fish's tooth melted in 32½ seconds. 12. The asbestos seemed condensed a little in 28 seconds, but it was now something cloudy; Mons. Villette says, that the glass usually calcines it. 13. A golden marchasite broke in pieces, and began to melt in about 30 seconds. 14. A silver sixpence melted in 7½ seconds. 15. A King William's copper halfpenny melted in 20 seconds, and ran with a hole in it in 31. 16. A King George's halfpenny melted in 16 seconds, and ran in 34. 17. Tin melted in three seconds. 18. Cast iron in 16 seconds. 19. Slate melted in

three seconds, and had a hole in six. 20. Thin tile melted in four seconds, and had a hole and was vitrified through in 80. 21. Bone calcined in four seconds, and vitrified in 33 22. An emerald was melted into a substance like a turquois stone. 23. A diamond, weighing four grains, lost $\frac{1}{8}$ of its weight.

An Account of the extraordinary Meteor seen all over England, on the 19*th of March*, 1718–9. *By Edm. Halley, LL.D.*

Our very worthy vice-president, Sir Hans Sloane, being abroad at that time, happened to have his eyes turned towards it at its first eruption; of which he gave the following account: That walking in the streets in London, at about a quarter after eight at night, he was surprised to see a sudden great light, far exceeding that of the moon, which shone very bright. He turned to the westward, where the light was, which he apprehended at first to be artificial fire-works or rockets. The first place he observed it in was about the Pleiades northerly, whence it moved after the manner of a falling star, but more slowly, in a seeming direct line, descending a little beyond and below the stars in Orion's belt, then in the S.W. The long stream appeared to be branched about the middle, and the meteor in its way turned pear-fashioned or tapering upwards. At the lower end it came at last to be larger and spherical, though it was not so large as the full moon. Its colour was whitish, with a tint of blue, of a most vivid dazzling lustre, which seemed in brightness very nearly to resemble, if not surpass, that of the body of the sun in a clear day. This brightness obliged him to turn his eyes several times from it, as well when it was a stream as when it was pear-fashioned and a globe. It seemed to move in about half a minute or less, about the length of 20°, and to go out about as much above the horizon. There was left behind it, where it had passed, a track of a cloudy or faint reddish yellow colour, such as red-hot iron or glowing coals have, which continued more than a minute, seemed to sparkle, and kept its place without falling. This track was interrupted, or had a chasm towards its upper end, at about two thirds of its length. He did not hear any noise it made; but the place where the globe of light had been continued, for some time after it was extinct, of the same reddish-yellow colour with the stream, and at first some sparks seemed to issue from it, such as come from red-hot iron beaten on an anvil.

All the other accounts of the phenomenon, in London, agree in this, that the splendour was little inferior to that of the sun; that within doors the candles gave no manner of light, and in the streets not only all the stars disappeared, but the moon, then nine days old, and high near the meridian, the sky being very clear, was so far effaced as to be scarcely seen, at least not to cast a shade, even where the beams of the meteor were intercepted by the houses; so that, for some few seconds of time, in all respects it resembled perfect day.

Now the situation of the three cities, London, Oxford, and Worcester, being nearly on the same W.N.W. point, on which the track of the meteor had its greatest altitude above the horizon, equal to the angle of its visible way; if we suppose it at London to have been 27° high, and at the same time at Worcester to be 65° high, in the plane of the vertical circle passing through London and Worcester; supposing, likewise, the distance between them to be 90 geographical miles, or one degree and a half of an arch of a great circle of the earth, we shall, by an easy trigonometrical calculus, find the perpendicular height to have been 64 such miles.

When it first broke out over Tiverton, its diameter was half a degree; and its horizontal distance being 150 geographical miles from London, and its altitude 60, the hypothenusal, or real distance from the eye, will be more than 160 such miles; to which radius the subtense of half a degree will be above an English mile and a half, being about 2800 yards nearly. After the same manner it is difficult to assign its due velocity, while some make it half, others less than a quarter, of a minute, in passing from its first explosion to its last extinction: but the distance it moved in that time being about 3°, or 180 geographical miles, we may modestly compute it to have run above 300 such miles in a minute; which is a swiftness wholly incredible.

Of several accidents that were reported to have attended its passage, some were the effect of pure fancy; such as the hearing it hiss as it went along, as if it had been very near at hand: some imagined they felt the warmth of its beams; and others thought they were scalded by it. But what is certain, and no way to be disputed, is the wonderful noise that followed its explosion. All accounts from Devon and Cornwall, and the neighbouring counties, are unanimous, that there was heard there, as it were the report of a very great cannon, or rather of a broadside, at some distance, which was soon followed by a rattling noise, as if many small arms had been promiscuously discharged. What was peculiar to this sound

was, that it was attended with an uncommon tremour of the air, and every where in those counties very sensibly shook the glass-windows and doors in the houses, and according to some, even the houses themselves, beyond the usual effect of cannon, though near; and Mr. Cruwys at Tiverton, on this occasion, lost a looking-glass, which being loose in its frame, fell out on the shock, and was broken. We do not yet know the extent of this prodigious sound, which was heard, against the then easterly wind, in the neighbourhood of London; and by the learned Dr. Tabor, who distinctly heard it beyond Lewes in Sussex.

An Account of some Experiments to find how much the Resistance of the Air retards falling Bodies. By J. T. Desaguliers, LL.D.

I took twelve balls, six of which were solid leaden globes of about two inches diameter; three hollow glass balls of about five inches diameter; and three light pasteboard hollow globes of about the same diameter; and having carried them to the upper gallery in the lantern, on the dome of St. Paul's church, I let them fall down by two at a time in the following manner:

First, a leaden ball and a glass ball; 2dly, a leaden ball and a glass ball; 3dly, a leaden ball and a glass ball. Then I let fall, in the same manner, the three other leaden balls, each with a pasteboard ball.

After that, having the leaden and pasteboard balls brought up again, I repeated the experiment twice more with a leaden and pasteboard ball; then I made the experiment twice more with a pasteboard ball alone, to see how long it would be in falling.

On the whole it appeared, that the leaden balls were a very little more than 4½ seconds in falling; the two largest of the glass balls six seconds; and the pasteboard balls 6½ seconds.

The height of the gallery, from whence the bodies fell, was 272 feet above the pavement of the church, then covered with boards, on which they fell.

A pail of water thrown down met with such a resistance in falling 272 feet through the air, that it was all turned into drops like rain.

On the Plague at Constantinople. By EMANUEL TIMONE, *M.D.*

IT is proved by historical documents, as well as by daily observation, that the plague is brought from Egypt to Constantinople. Here it is fostered and retained; and although this city is scarcely ever free from the seminia of a former pestilence, yet a new fomes of contagion is every now and then imported. It is for the most part suppressed by a severe degree of winter cold.

The following are the symptoms; namely, fever, buboes, carbuncles, exanthemata, head-ache, phrenitis, drowsiness in some, wakefulness in others, anxiety, debility, or great prostration of strength, dull or muddy appearance of the eyes, palpitation of the heart, dryness of the tongue, vomiting, hiccup, worms, diarrhœa, bleeding at the nose, bloody urine, spitting of blood; pains of the side, liver, kidneys, and other parts. To these I add a weariness and soreness of the limbs, shivering sometimes followed by heat, but more frequently not; nausea without vomiting, vertigo, trembling of the hands from the very beginning of the disorder. Of these symptoms there is not one which is inseparable from the disorder, not even buboes, carbuncles, and exanthemata. In many instances there is no fever. Hence it may be established as a general rule, that whenever a disorder is accompanied with buboes, carbuncles, &c. we may with certainty pronounce it to be the plague; but that although such symptoms be wanting we cannot with certainty pronounce the contrary. Thus many who are seized with the plague experience merely a slight shivering, not so much as in a common cold; and for several day's none of the characteristic symptoms show themselves, but at length they burst forth all at once. Some after taking the infection only feel a degree of languor: they are capable of walking about, and going through their usual occupations without inconvenience; but on the third or fourth day they suddenly drop down, and die on the spot.

In some constitutions the plague remains dormant for several days, and then comes into action. If a person who is recovering from the plague commits any great error in diet, before the fortieth day, and a fresh bubo appears, he dies. It is very unusual for a person who has been perfectly recovered from an attack of the plague, to have it a second time during the same year. A person who had lived in an infected house for some months without taking the plague, was at length seized with it. Old men, for the most part, escape infection; young persons, on the contrary, are very liable to take it.

Foreigners are more susceptible of it than the native inhabitants. Of all nations the Armenians are the least liable to infection. They eat very little animal food, but are much addicted to the use of onions, leeks, garlick, and wine. It is not safe to eat pork during the plague. Nothing predisposes more to the taking of infection than passions of the mind, and particularly grief and fear. Houses which are kept clean and neat are not so readily infected as those that are dirty. Cachectic subjects, and persons labouring under the jaundice and various other chronic disorders, either entirely escape infection, or if they take the plague, they have it favourably. On the contrary, it is particularly fatal to persons of a florid complexion and robust constitution.

In 1712 the plague at Constantinople spread with increasing prevalency at the end of May, and arrived at its height towards the end of July. A person whom I employed to make observations counted above ninety dead bodies in one day. The Etesian winds blew strongly; afterwards the wind changed to the south. The first week after this change in the wind, viz. to the south, he counted only about forty dead bodies per diem; the second week, about thirty; the third week, not so many as twenty; which last is not more than the ordinary number of daily deaths at that time of the year in healthy seasons.

Of the Infinity of the Sphere of fixed Stars. By Edmund Halley, LL.D.

The system of the world, as it is now understood, is taken to occupy the whole abyss of space, and to be as such actually infinite; and the appearance of the sphere of fixed stars, still discovering smaller and smaller ones, as we apply better telescopes, seems to confirm this doctrine. And, indeed, were the whole system finite, though never so extended, it would still occupy no part of the infinitum of space, which necessarily and evidently exists.

I have attentively examined what might be the consequence of an hypothesis, that the sun being one of the fixed stars, all the rest were as far distant from one another as they are from us; and by a due calculation I find, that there cannot, on that supposition, be more than 13 points in the surface of a sphere, as far distant from its centre as they are from one another; and I believe it would be hard to find how to place 13 globes of equal magnitude, so as to touch one in centre; for the 12 angles of the icosaedron are from

another very little more distant than from its centre; that is, the side of the triangular base of that solid is very little more than the semi-diameter of the circumscribed sphere, it being to it nearly as 21 to 20; so that it is plain that somewhat more than 12 equal spheres may be posited about a middle one; but the spherical angles or inclinations of the planes of these figures being incommensurable with the 360 degrees of the circle, there will be several interstices left, between some of the 12, but not such as to receive in any part the 13th sphere.

Hence it is no very improbable conjecture, that the number of the fixed stars of the first magnitude is so small, because this superior appearance of light arises from their nearness; those that are less showing themselves so small by reason of their greater distance. Now there are in all only 16 fixed stars, in the whole number of them, that can indisputably be accounted of the first magnitude; of which four are Extra Zodiacum; viz. Capella, Arcturus, Lucida Lyræ, and Lucida Aquilæ, to the north; four in the way of the moon and planets, viz. Palilicium, Cor Leonis, Spica, and Cor Scorpii; and five to the southward, that are seen in England, viz. the foot and right shoulder of Orion, Sirius, Procyon, and Fomalhaut; and there are three more that never rise in our horizon, viz. Canopus, Acharnar, and the foot of the Centaur. But that they exceed the number 13 may easily be accounted for from the different magnitudes that may be in the stars themselves; and perhaps some of them may be much nearer to one another than they are to us; this excess of number being found singly in the signs of Gemini and Cancer.

Account of a Boy who lived a considerable Time without Food. By Patrick Blair, *M.D.*

This account is of a boy, of 15 years of age, said to have lived three years without eating or drinking; during which time he had several severe fevers, with sometimes the loss of the use of his limbs, and one while of his speech. After the three years he gradually recovered tolerable health, excepting ------ of one of his limbs, and taking extremely little food.

Concerning a new Island lately raised out of the Sea, near Tercera, one of the Azores. By Tho. Forster, *Esq.*

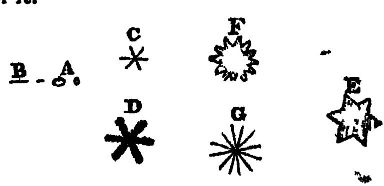
John Robinson, master of a small vessel, arrived at Tercera, Dec. 16, 1720; near which island he saw a fire break

out of the sea. Dec. [illegible] we got under sail at 12 o'clock at night, and stood from Angras, S.E. The next day at two in the afternoon, we made an island, all fire and smoke; and continued our course till the ashes fell on our deck, like hail or snow, all night. We bore from it, the fire and smoke roaring like thunder, or great guns. At day-break we stood towards it again: at 12 o'clock we had a good observation, two leagues south from it. We sailed round it, and so near, that the fire and matter it threw out, had like to have done us damage: but a small gale at S.E. sprung up, and carried us clear, to our great joy. The breeze was accompanied with a small shower of rain, which caused a great dust to fall on our deck. With this breeze we stood away for Tercera. The governor informed us that the fire broke out Nov. 20. 1720, in the night, and that it was accompanied by an earthquake, which shattered many houses in the town of Angra, and places adjacent. Prodigious quantities of pumice-stones and half-broiled fish were found floating on the sea, for many leagues round the island, and abundance of sea-birds hovering about it.

Observations on the Figures of Snow. By the Rev. BENJ. LANGWITH, *D.D.*

ON Jan. 30. 1723, a little after nine in the morning, weather cold, wind south-westerly, but not very high, barometer above 30 inches, I saw that pretty phenomenon of the star-like snow, and though on comparing my observations afterwards with those of Descartes, Dr. Grew, and Mr. Morton, I find I have but little to add on the subject; yet, as I observed the progress of nature, in this sort of crystallisation, with a great deal of pleasure, I hope it will not be disagreeable to you to receive an account of it.

I shall begin with the most simple figures A and B, of which the former is a roundish pellet of ice; the second, a small oblong body, with parallel sides,



which is often as fine as a hair. Of this latter kind the flakes of snow chiefly consist; and though they look white to the eye, yet when viewed with a small magnifier of a microscope, they appear like so many transparent needles of ice thrown together, without any order.

The next figure is C, in which the pellet has shot out six of those small bodies of equal length, and set at equal angles; of this kind I saw a considerable number.

The next step in the crystallisation is D, in which those bodies are lengthened, and have shot out a great many more from their sides, at equal angles, but unequal lengths, growing continually shorter and shorter, till they terminate in a point. I measured some of these, and found them to be about one quarter of an inch in breadth. I saw but very few of them in perfection, for the collateral shoots were so exquisitely fine, as to be liable to be broken in their fall, or confounded together by the least degree of heat.

Of the next kind, E, I saw a very great number, which being examined by the microscope, plainly appeared to be nothing but the former in disorder. The edges of these were, in general, very irregular, but some of them happened to be so indented, as to look like the jagged leaves of plants.

The next kind, F, had 12 points regularly disposed, and probably might consist of two of the former so joined together, as to cut their angles equally.

I saw but very few figures of 12 points, and those mostly imperfect in one respect or other.

Experiments concerning the Degrees of Heat of boiling Liquors. By M. Fahrenheit.

M. Fahrenheit finding, in the history of the Royal Academy of Sciences, that M. Amontons had, by means of a thermometer of his own invention, discovered that water boils with a fixed degree of heat, was very desirous of making such another thermometer, to view with his own eyes this curious phenomenon of nature, and be convinced of the truth of the experiment.

Having made such a thermometer, the event answered his expectation. The issue of the experiments is exhibited in the following table: the first column shows the several liquors used, the second the degree of heat each liquor acquired by boiling.

Liquors.	The degrees of heat acquired by boiling.
Spirits of wine	176
Rain water	212
Spirit of nitre	242
Lixivium of pot-ash	240
Oil of vitriol	546

Volatile oils begin to boil with a low degree of heat; but their heat continually increases by boiling; the reason of which may probably be this, viz. that the more volatile particles fly off, while the resinous ones remain behind.

But fixed oils require so great a degree of heat, that the mercury in the thermometer begins to boil at the same time with them; and hence their degree of heat can scarcely be found with certainty in the manner above mentioned.

Experiments and Observations on the Freezing of Water in Vacuo. By M. Fahrenheit.

March 2. 1721, he exposed to the cold a glass ball, about an inch in diameter, exhausted of air, and filled with rain-water almost half full; the temperature of the air in the thermometer was marked at 15 degrees. In an hour after, he found the water still fluid in the ball. He then left the ball exposed all night in the open air, and next day, viz. the third of March, at 5 o'clock in the morning, he found the water still fluid, and the thermometer at the same degree; the cause of which unexpected phenomenon he attributed to the absence of the air. To discover the truth of this conjecture, he broke the extremity of the tube, that the exhausted ball might be again filled with air; on which the whole mass of water was suddenly mixed with very thin lamellæ of ice. He broke the ball, and putting some of the ice into some water in a glass cup, he observed it floated.

A little time after, he observed all the water mixed with icy lamellæ; yet the greatest part of the water still continued fluid between the interstices; the thermometer, put into this mixture, stood at 32 degrees. On repeating the experiment with two other balls, and after preparing them in the manner above mentioned, he exposed them for an hour in the open air, the thermometer being then at 20 degrees; an hour after, he found the water still fluid in both the balls, but after the exhausted ball was again filled with air, the water, as in the former experiment, was very soon mixed with icy lamellæ; and their production was so instantaneous, that it could hardly be observed with the eye. Before he broke one of the balls, he separated the water in the said cup from the icy lamellæ, on which he broke the ball, and threw the ice into water; the ice, it is true, floated on the water, but he in vain expected the production of the lamellæ in the cup.

Concerning the Difference in the Height of a Human Body, between Morning and Night. By the Rev. Mr. WASSE.

MR. WASSE having measured a great many sedentary people and day-labourers, of all ages and shapes, found the difference in their height between the morning and night to be near an inch. He tried himself when sitting, and found it in like manner; particularly, August 21. 1723, he sat down, at 11 in the morning, and fixed an iron pin so as to touch it, and that but barely. Afterwards fatiguing himself for half an hour with a garden-roller, the consequence was, that at $12^h\ 30^m$ he could not reach the nail sitting, by about $\frac{5}{10}$ of an inch. At two the same day he wanted near $\frac{8}{10}$ of an inch. On the 21st, at $6^h\ 30^m$ in the morning, he touched the nail fully; and after the above-mentioned exercise for only a quarter of an hour, at $7^h\ 14^m$ he fell short almost as much as before. On the 27th, having sat up late with some friends, he was faint, and felt himself heavy on the ground, and without any spring, and at nine next morning he did not reach the nail, though he had used no exercise. He rode out, but could not reach it that day. On the 28th he rode about four miles; and whereas at six that morning he reached the nail, he had lost $\frac{8}{10}$ of an inch by eight. Sept. 19th he came from Oxford a little tired, and next morning at eight wanted one half of an inch. After studying closely, though he never stirred from the writing-desk, yet in five or six hours he lost near an inch. All the difference between labourers and sedentary people is, that the former are longer in losing their morning height, and sink rather less in the whole than the latter. When the height is lost, it can be regained by rest that day, or by the use of the cold bath.

The alteration in the human stature, it seems, proceeds from the yielding of the cartilages between the vertebræ, to the weight of the body in an erect posture.

The Specific Gravities of several Bodies. By M. FAHRENHEIT, R.S.S.

GOLD -	19081	Malacca tin	7364
Mercury -	13575	English tin - -	7313
Lead -	11350	White marcasite -	9850
Silver -	10481	Regulus of antimony	6622
Swedish copper	8834	Brass - - -	8412
Japanese copper	8799	Rock-crystal -	2669
Iron -	7817	Homogeneous Pyrites	2584

Sea salt	2125	The same	1571½
Nitre	2150	Good aquafortis	1409
Alum	1738	Spirit of nitre	1293½
Very white sugar	1606½	RAIN-WATER	1000
Oil of vitriol	1877½	Rape-seed oil	913
Lixivium of pot-ash, fully saturated with salt	1563	Alcohol of wine	826
		The same, purer	825

Of the Currents at the Straits' Mouth.

CAPE SPARTEL, and Cape Trafalgar, from the western ocean, are known to make the Straits' mouth; from whence a current, in the middle of the channel, which is about five leagues broad, between the Barbary and Spanish land, runs at least two miles each hour, as far as Ceuta Point; and there the two coasts opening about 18 leagues distant from each other, the current does not run above one mile an hour, and so continues as far as Cape de Gat, which is 70 leagues up the Mediterranean.

It is very remarkable, that, in the year 1712, Mons Du L'Aigle, that fortunate and generous commander of the privateer called the Phœnix of Marseilles, giving chase, near Ceuta Point, to a Dutch ship bound for Holland, he came up with her in the middle of the gut, between Tariffa and Tangier, and there gave her one broadside, which directly sunk her, all her men being saved by Mons. Du L'Aigle; and a few days after, the sunk ship, with her cargo of brandy and oil, arose on the shore near Tangier, which is at least four leagues to the westward of the place where she sunk, and directly against the strength of the current; which has persuaded many men that there is a re-currency in the deep water, in the middle of the gut, that sets outwards to the grand ocean, which this accident very much demonstrates; and, possibly, a great part of the water, which runs into the Straits, returns that way, and along the two coasts before mentioned; otherwise this ship must of course have been driven towards Ceuta, and so upwards.

The water in the gut must be very deep, several of the commanders of our ships of war having attempted to sound it with the longest lines they could contrive, but could never find any bottom.

An Essay on the Natural History of Whales. By the Hon. PAUL DUDLEY.

THE right or whalebone whale is a large fish, measuring 60 or 70 feet in length, and very bulky, having no scales, but a soft fine smooth skin, no fins, but only one on each side, from five feet to eight feet long, which they are not observed to use, but only in turning themselves, unless while young, and carried by the dam on the flukes of their tails; when with those fins they clasp about her extremity, and so hold themselves on. The eye of a whale is about the size of an ox's eye, and situated in the hinder part of the head on each side, and where the whale is broadest; for his head tapers away forward from his eyes, and his body tapers away backward; his eyes are more than half way his depth, or nearest his under part; just under his eyes are his two fins before mentioned: he carries his tail horizontally, and with that he sculls himself along.

The scrag-whale is near akin to the finback; but instead of a fin on his back, the ridge of the hinder part of his back is scragged with half a dozen knobs; he is nearest the right whale in figure and for quantity of oil; his bone is white, but will not split.

The finback-whale is distinguishable from the right whale by having a large fin on his back, from 2½ to four feet long. He has also two side fins, as the whalebone-whale, but much longer, measuring six or seven feet. This fish is somewhat longer than the other, but not so bulky; much swifter and very furious when struck, and held with great difficulty: their oil is not near so much as that of the right whale, and the bone of little profit, being short and knobby. The belly of this whale is white.

The bunch or humpback whale is distinguished from the right whale by having a bunch in the place of the fin in the finback. This bunch is as large as a man's head, and a foot high, shaped like a plug pointing backwards. The bone of this whale is worth but little, though somewhat better than the finback's. His fins are sometimes 18 feet long, and very white: his oil much as that of the finback. Both the finbacks and humpbacks are shaped in reeves lengthwise, from head to tail, on their bellies and their sides, as far as their fins, which are about half way up their sides.

The spermaceti-whale is a fish much of the same dimension with the other, but of a greyish colour; whereas the others are black; he has a bunch on his back like the hump-

back, but then he is distinguished by not having any whalebone in the mouth; instead of which, there are rows of fine ivory teeth in each jaw, about five or six inches long. They are a more gentle fish than the other whales, and seldom fight with their tails. The spermaceti-oil, so called, lies in a great trunk about four or five feet deep, and 10 or 12 feet long, near the whole depth, breadth, and length of the head, it is disposed in several membranous cells, and covered not with a bone, but a thick gristly substance below the skin.

Their care of their young is very remarkable; they not only carry them on their tails, and suckle them, but often rise with them for the benefit of the air; and however they may be chased or wounded by the cruelty of man, yet as long as they have sense, and perceive life in their young, they will never leave them, nor will they then strike with their tail; and if, in their running, the young one loses its hold and drops off, the dam comes about, and passing underneath, takes it on again. Whales are very gregarious, being sometimes found 100 in a scull, and are great travellers. In the fall of the year, the right or whalebone whales go westward, and in the spring eastward But the several kinds of whales do not mix with each other, but each sort by themselves.

Their way of breathing is by two spout-holes in the top of the head. The spermaceti has but one, and that on the left side of the head. Once in a quarter of an hour, when not disturbed, they are observed to rise and blow, spouting out water and air, and to draw in fresh air; but when pursued they will sometimes keep under water half an hour or more; though when a cow has her calf on her tail, she rises much oftener, for the young one to breathe, without breathing herself.

The fish that prey upon the whales, and often kill the young ones, are by the whalemen called killers. These killers are from 20 to 30 feet long, and have teeth in both jaws that lock into each other. They have a fin near the middle of their back four or five feet long. They go in company by dozens, and set upon a young whale, and will bait him like so many bull-dogs; some will lay hold of his tail to keep him from threshing, while others lay hold of his head, and bite and thresh him, till the poor creature, being thus heated, lolls out his tongue, and then some of the killers catch hold of his lips, and if possible of his tongue; and after they have killed him, they chiefly feed upon the tongue and head; but when he begins to putrefy they leave him.

Ambergris is found only in the spermaceti-whales, and con-

sists of balls or globular bodies; of various sizes, from about three to 12 inches diameter, and will weigh from a pound and a half to 22 pounds, lying loose in a large oval bag or bladder, of three or four feet long, and two or three feet deep and wide, almost in the form of an ox's bladder.

Of Magnetical Powers. By M. Muschenbroek.

M. Muschenbroek wished to try, whether loadstones operate on each other at different distances, according to a certain proportion. He thought, that if he took two magnets, and hung one of them by a thread, at different distances above the other, and if he tied the end of the thread to a balance, he might weigh the quantity of the force with which the magnets would act on each other; which succeeded accordingly.

The following table contains the experiments made at the different distances of inches and lines; and corresponding to them are columns, with the number of grains which counterpoise the force called attraction at these distances: —

Distance. Inches.	Lines.	Grains of force.	Distance. Lines.	Grains of force.
12	0	$3\frac{1}{10}$	4	172
10	0	$0\frac{1}{4}$	3	190
9	0	$0\frac{1}{2}$	2	215
	12	$70\frac{1}{2}$	1	250
	8	106	$\frac{1}{2}$	290
	6	131 In the very point of contact or	0	340

The following table exhibits the observations he made with another very good small magnet, while the lower terrella was the same as before, and firmly fixed on a table: these experiments were made in the same manner as the former: —

Distance. Inches.	Lines.	Grains of force.	Distance Lines	Grains of force.
1	0	23	2	79
	8	$30\frac{1}{4}$	1	140
	6	$38\frac{1}{2}$	$\frac{1}{2}$	186
	4	$50\frac{1}{2}$	0	340
	3	62		

But here again occur great irregularities, from which nothing can be concluded: this only is surprising, that though the magnet used in the second experiment was smaller than that in the first, yet, in the point of mutual contact it was attracted with equal forces, namely, 340 grains, while in other distances the attraction was much less. He repeated these experiments with other magnets, and particularly with one whose force was so great, as to affect a magnetic needle at

the distance of 14 Rhinland feet. But from all the experiments he could only conclude, that there is no assignable proportion between the forces and distances. He wished to observe, whether the force of the magnet was the same every day, or greater or less in summer than in winter; but he found by several experiments, that the force is less in summer than in winter. Both poles of the magnet do not act with the same force: the north poles are stronger than the south.

While he made these experiments with magnets placed at different distances from each other, he interposed very thick pieces of lead, tin, silver, copper, and a pretty large mass of mercury, in order to see whether the magnetic effluvia would not be intercepted; and if not entirely, yet if in some measure at least: but he observed, that whatever bodies he interposed, the magnetic forces were always the same, as if no such bodies at all intervened; which he thinks, indeed, a thing surprising, and not to be understood: for we are not to suppose that these bodies are so porous as to have no solidity; if therefore they have some solid parts, as they have a great deal, shall not these hinder the approach of a foreign fluid, or its egress from the magnet, or some of it at least; but experiments show, that the magnetic forces are nowise hindered.

But he takes the strongest argument from the repelling forces of magnets, which are much weaker than the attracting forces, as appears from the experiments below; so that a fluid must necessarily come from without towards the magnet, which meeting the other magnet, impels the one fluid towards the other, and which enters the magnet; and because the magnetic attraction is much stronger than the repulsion, a greater quantity of the fluid enters into the magnet than passes out from it: whence the magnet must necessarily be soon filled with this fluid, so as to be no longer porous; nor can it be supposed, that this fluid is emitted from all parts of the magnet, as it were; for the attraction is in every point of the magnet, but the repulsion is only in the poles.

In order to show that the magnetic repulsion is less than the attraction, the following table contains the experiments made with the last-mentioned magnets:—

Distance. Inches.	Lines.	Grains of repulsion.	Distance. Lines.	Grains of repulsion.
11	11	½	6	25½
9	0	1	5	27½
6	1	2	4	29
1	0	24	1	34
	10	24	In the very point of contact 0	44

An Account of the Strata in Coal-Mines, &c. By JOHN STRACHEY, *Esq. F.R.S.*

MR. S. has been under ground, and viewed several coal-works in Scotland and Northumberland, and their several strata. At Widdrington they have four fathoms of clay, then a seam of coal, about six inches thick, not worth working; then a white freestone; then a hard stone, called whin; then two fathoms of clay; then a white soft stone; and under that a vein of coal three feet nine inches thick. This is a small coal of the same nature, but not so good as the Newcastle coal which comes to London market. These veins dip to the south-east, one yard in 20.

Near Tranent, in East-Lothian, in Scotland, the coal dips also to the south-east, in the same proportion; but at Baldoe, in the parish of Campsy, three miles from Kylsith, it dips to the north-east; and at Madestone, near Falkirk, to the same point, and in the same proportion.

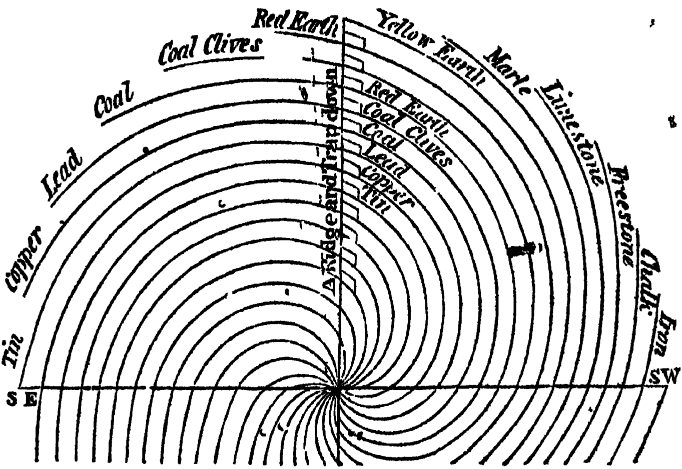
The strata of earths and minerals, at these places, agree very nearly: they have, as the ground rises or falls, one, two, or three fathoms of clay; then 11 fathoms of slate, or coal-clives; one fathom of limestone; under that two fathoms of slate, earth, and stone; and then coal. And all these agree in this, that the pits generally need no timber, and have a good roof, which is supported by pillars of coal, which they leave in the working.

At Baldoe, the coal is commonly 45 inches thick; and all along, for some miles eastward thence, on the sides of the hills, are crops of coal and limestone; and the tenants often spit up as much as will serve them for a winter's burning, just under the surface; for there wants a market, and it is scarcely worth working for sale. And to the north-west and north, in the drift of the coal in higher ground, and consequently lying over it, there appear, in the sides of the hills, seams of spar and lead, the drift of which is north-east, and lies almost perpendicular; but what obliquity there is pitches to the south-east.

At Auchenclaugh, six miles east from Kylsith, there is a coal 18 feet thick: this dips one foot in three, and is not pursued, by reason of water; and, for want of a market, will not pay the cost of draining.

At Madestone, the coal is four feet and a half thick, and above three fathoms and a half deep: they land it on girls' backs. Near Tranent three different veins are wrought; the undermost is about 14 fathoms from the surface, called the

Splenty coal, four feet and a half thick; it is a hard, but not large coal; it makes a clear and strong fire; lies ten fathoms under the main coal, which is nine or ten feet thick, and comes out very large. Its roof is of freestone, under which Mr. S. walked backward and forward two hours; but had no opportunity to make any other observations on the upper vein, than that it is about four feet thick, and neither so hard nor large as the other.



The engraving represents the strata in a globular projection, supposing the mass of the terraqueous globe to consist of the foregoing, or perhaps of 10,000 other different minerals, all originally, while in a soft and fluid state, tending towards the centre. It must mechanically, and almost necessarily follow, by the continual revolution of the crude mass from west to east, like the winding up of a jack, or rolling up the leaves of a paper-book, that every one of these strata, though they all reach the centre, must, in some place or other, appear to the day; in which case there needs no specific gravitation to cause the lightest to be uppermost, &c. for every one in its turn, in some place of the globe or other, will be uppermost; and were it practicable to sink to the centre of the earth, all the strata, that are, would be found in every part.

An Account of the Strata of Bogs, and of Horns found under Ground in Ireland. By Mr. James Kelly.

Marl is found only in the bottoms of low bogs, where it is searched for with augres, and found at the depth of seven, eight, or nine feet; this in many places occasions great expence in draining off the water. For the first three feet they meet with a fuzzy sort of earth, called moss, proper to make turf for fuel; then a stratum of gravel about half a foot; under which, for about three feet more, is a more kindly moss, that would make a more excellent fuel; this is altogether mixed with timber, but so rotten, that the spade cuts it as easily as the earth; under this, for the depth of three inches, are leaves, mostly of oak, that appear fair to the eye, but will not bear a touch. This stratum is sometimes interrupted with heaps of seed, that seem to be broom or furze seed; and in one place there appeared to be gooseberries and currants; in other places in the same stratum they find sea-weed, and other things as odd to be at that depth; under this appears a stratum of blue clay, of half a foot thick, fully mixed with shells; this is esteemed good marl, and thrown up as such; then appears the right marl, commonly two, three, or four feet deep, and in some places much deeper, which looks like buried lime, or the lime that tanners throw out of their lime-pits, only that it is much mixed with shells, being the small periwinkles, called fresh-water wilks; though there are among them abundance of round red periwinkles, such as are often thrown out on the sea-shore.

Among this marl, and often at the bottom of it, are found very great horns, which, for want of another name, are called elk-horns: where they join the head, they are thick and round; and at that joining there grows out a branch of about a foot long, that seems to have hung just over the beast's eyes; it grows round above this for about a foot or more; then spreads broad, which ends in branches, long and round, turning with a small bend. They have also found shanks and other bones of these beasts in the same place.

On the Controversy among Mathematicians, concerning the Proportion of Velocity and Force in Bodies in Motion. By the Rev. Dr. Samuel Clarke.

It is contended, that the force of any body in motion is proportional not to its velocity, but to the square of its velocity. The absurdity of which notion I shall first make appear,

and then show what it is that has led these gentlemen into error.

In the nature of things, it is evident, that every effect must necessarily be proportionate to the cause of that effect; that is, to the action of the cause, or the power exerted at the time when the effect is produced. To suppose any effect proportional to the square or cube of its cause, is to suppose that an effect arises partly from its cause, and partly from nothing.

In a body in motion, there may be considered, distinctly, the quantity of the matter, and the velocity of the motion. The force arising from the quantity of the matter, as its cause, must necessarily be proportional to the quantity of the matter; and the force arising from the velocity of the motion, as its cause, must necessarily be proportional to the velocity of the motion. The whole force, therefore, arising from these two causes must necessarily be proportional to these two causes taken together. And, therefore, in bodies of equal size and density, or in one and the same body, the quantity of matter continuing always the same, the force must necessarily be always proportional to the velocity of the motion. If the force were as the square of the velocity, all that part of the force, which was above the proportion of the velocity, would arise out of nothing.

Whenever any effect whatever is in a duplicate proportion, or as the square of any cause, it is always either because there are two causes acting at the same time, or that one and the same cause continues to act for a double quantity of time.

The resistance made to a body moving in any fluid medium is in a duplicate proportion to the velocity of its motion; because, in proportion to its velocity, it is resisted by a greater number of particles in the same time; and again, in proportion to its velocity, it is resisted by the same particles singly with a greater force, as being to be moved out of their places with greater velocity.

What I have thus demonstrated concerning any force, considered as the cause producing an effect, and concerning the time, during which the force operates, is on all hands acknowledged to be true concerning velocity. And, therefore, velocity and force, in this case, are one and the same thing. So that, to affirm force to be as the square of the velocity, is to affirm that the force is equal to the square of itself.

Observations made by a young Gentleman, who was born blind, or lost his Sight so early, that he had no Remembrance of ever having seen, and was couched between 13 *and* 14 *Years of Age. By Mr.* WILLIAM CHESSELDEN, *F.R.S.*

THIS young gentleman knew colours asunder in a good light, yet when he saw them after he was couched, the faint ideas he had of them before were not sufficient for him to know them by afterwards; and therefore he did not think them the same, which he had before known by those names. Now scarlet he thought the most beautiful of all colours, and of others the most gay were the most pleasing; whereas the first time he saw black, it gave him great uneasiness, yet after a little time he was reconciled to it; but some months after, seeing by accident a negro woman, he was struck with great horror at the sight.

When he first saw, he was so far from making any judgment about distances, that he thought all objects whatever touched his eyes, as he expressed it, as what he felt did his skin; and thought no objects so agreeable as those which were smooth and regular, though he could form no judgment of their shape, or guess what it was in any object that was pleasing to him.

He knew not the shape of any thing, nor any one thing from another, however different in shape or magnitude; but on being told what things were, whose form he before knew from feeling, he would carefully observe, that he might know them again; but having too many objects to learn at once, he forgot many of them; and, as he said, at first he learned to know, and again forgot a thousand things in a day.

One particular only, though it may appear trifling, Mr. C. relates: having often forgot which was the cat, and which the dog, he was ashamed to ask; but catching the cat, which he knew by feeling, he was observed to look at her steadfastly, and then setting her down, said, So, puss! I shall know you another time.

He was very much surprised, that those things which he had liked best did not appear most agreeable to his eyes, expecting those persons would appear most beautiful that he loved most, and such things to be most agreeable to his sight that were so to his taste. They thought he soon knew what pictures represented, which were showed to him, but they found afterwards they were mistaken: for about two months after he was couched, he discovered, at once, they represented solid bodies; when to that time he considered them only

as party-coloured planes, or surfaces diversified with variety of paint; but even then he was no less surprised, expecting the pictures would feel like the things they represented, and was amazed when he found those parts, which by their light and shadow appeared now round and uneven, felt only flat like the rest; and asked which was the lying sense, feeling, or seeing?

Being shown his father's picture in a locket at his mother's watch, and told what it was, he acknowledged a likeness, but was vastly surprised; asking, how it could be that a large face could be expressed in so little room, saying, it should have seemed as impossible to him as to put a bushel of any thing into a pint.

At first, he could bear but very little sight, and the things he saw he thought extremely large; but on seeing things larger, those first seen he conceived less, never being able to imagine any lines beyond the bounds he saw; the room he was in he said he knew to be but part of the house, yet he could not conceive that the whole house could look larger. Before he was couched, he expected little advantage from seeing, worth undergoing an operation for, except reading and writing; for he said he thought he could have no more pleasure in walking abroad than he had in the garden, which he could do safely and readily. And even blindness, he observed, had this advantage, that he could go any where in the dark much better than those who can see; and after he had seen, he did not soon lose this quality, nor desire a light to go about the house in the night.

He said, every new object was a new delight, and the pleasure was so great, that he wanted ways to express it; but his gratitude to his operator he could not conceal, never seeing him for some time without tears of joy in his eyes, and other marks of affection; and if he did not happen to come at any time when he was expected, he would be so grieved, that he could not forbear crying at his disappointment.

A year after first seeing, being carried upon Epsom Downs, and observing a large prospect, he was exceedingly delighted with it, and called it a new kind of seeing. And now being lately couched of his other eye, he says, that objects at first appeared large to this eye, but not so large as they did at first to the other; and looking on the same object with both eyes, he thought it looked about twice as large as with the first couched eye only, but not double, that they could any ways discover.

An Account of Elephants' and Mammoths' Teeth and Bones, found under Ground. By Sir Hans Sloane.

It is observable, that among the vast variety of extraneous substances, lodged and found in several layers of the earth, at considerable depths, where it is impossible that they should have been bred, there are not so many productions of the earth as of the sea. And again, among those which must have originally belonged to the earth, there are many more remains of vegetables than of land animals.

It appears, however, by the histories of past times, and the accounts of many, both ancient and modern authors, that bones, teeth, and sometimes almost whole skeletons of men and animals, have been dug up, in all ages of which we have histories, and almost in all parts of the world, of which the most remarkable for their unusual size have been also the most noticed. Thus, for instance, in Ireland there have been found the horns, bones, and almost entire skeletons of a very large sort of deer, which is commonly believed to have been the moose-deer, an animal of an uncommon size, some of which kind are thought to be still living in some remote and unfrequented parts of the continent of America.

The tusk of an elephant was taken up, 12 feet deep, from among sand, or loam, in digging for gravel at the end of Gray's Inn Lane.

An extraordinary elephant's tooth, one of those which grow out of the upper jaw, and which for their magnitude and length have by some writers been accounted horns, was lately taken out of the earth by digging in Bowdon-parva Field in Northamptonshire. Even the native colour of it has been in a great measure preserved; but it is become brittle with lying in the earth; and was broken into three or four pieces transversely by the diggers in taking it up. One of them is somewhat above a yard, the other is two feet in length; but the whole tooth must needs have been at least six feet long; the thickest part of the larger piece is 16 inches round. The tooth lay buried above five feet deep in the earth. The strata, from the surface, downwards to the place where the tooth was lodged, were as follows: 1. The soil 13 or 14 inches. 2. Loam, a foot and a half. 3. Large pebbles, with a small mixture of earth among them, two feet and a half. 4. Blue clay. In the upper part of this stratum the tooth was found.

The tusk of an elephant, remarkable for its large size, and for its being so very entire, was found under ground in Siberia. The like tusks, and other bones of the elephant, are

found in sundry parts of Siberia to a considerable quantity, and the tusks and teeth in particular, when less corrupted, are used all over Russia for ivory. Henricus Wilhelmus Ludolfus, in the Appendix to his Russian Grammar, mentions them among the minerals of Russia, by the name of Mammotovoikost, and says, that the Russians believe them to be the teeth and bones of an animal living under ground, larger than any one of those above ground.

Among the hills to the north-east of Makofskoi, the mammoths' tongues and legs are found; as they are also particularly on the shores of the rivers Jenisei, Trugan, Mangasea, Lena, and near Jakutskoi, to as far as the frozen sea. The old Siberian Russians affirm, that the mammoth is very like the elephant, with this only difference, that the teeth of the former are firmer, and not so straight as those of the latter. They also are of opinion, that there were elephants in this country when this climate was warmer: but that after the deluge, the air, which was before warm, was changed to cold, and that these bones have lain frozen in the earth ever since, and so are preserved from putrefaction, till they thaw and come to light. These animals must be of necessity very large, though a great many lesser teeth are found. But no person ever saw one of these beasts alive, or can give any account of its shape.

Lawrence Lang, in the Journal of his Travels to China, takes notice of these bones, as being found about the river Jenisei, and towards Mangasea, along the banks, and in the hollows occasioned by the fall of the earth. He calls them maman-bones, and informs us that some of the inhabitants are of opinion, that they are the bones of the Behemoth, mentioned in the 40th chapter of Job. The same author affirms, from the report, as he says, of credible people, that there have been sometimes found horns, jaw-bones, and ribs, with fresh flesh and blood sticking to them. The same is confirmed by John Bernard Muller, in his account of the Ostiacks; who adds, that the horns in particular have been found sometimes all bloody at the broken end, which is generally hollow, and filled with a matter like concreted blood; that they find, together with these teeth, or horns, as he calls them, the skull and jaw-bones, with the grinders still fixed in them, all of a monstrous size; and that he himself, with some of his friends, has seen a grinder weighing more than 24 lb.

The accounts hitherto given of these maman-bones and teeth, or at least their most essential parts, are confirmed by a letter of Basilius Tatischow, director-general of the mines in Siberia, where he mentions the following pieces he had in his

own possession: a large horn, as he calls it, or tooth, weighing 183 pounds, which he had the honour to present to his Czarish majesty, and is now kept in the Czar's collection of curiosities at Petersburgh; another large horn, which he presented to the Imperial Academy at Petersburgh; another still larger than either of these two, which he caused to be cut, and carved himself several things from it, the ivory being very good; part of the skull, corrupted by having lain in the ground, and so large, that it seemed to him to be of the same size with the skull of a great elephant; the forehead, in particular, was very thick, and had an excrescence on each side, where the horns are usually fixed.

In Sir Hans Sloane's collection is one of the grinders of an elephant, which was likewise found in Northamptonshire. The above tooth was lodged at almost 12 feet depth in earth. Above it were the following strata: 1. The top earth, a blackish, clayey soil, about 16 inches. 2. Sandy clay intermixed with pebbles, five feet. 3. A blackish sand, with small white stones in it, one foot. 4. A loamy, softer sort of gravel, one foot. 5. A sharper gravel, about two feet. The tooth was found a foot and a half deep in this stratum of gravel. Below this fifth stratum there was a blue clay.

In his collection of quadrupeds and their parts is part of an elephant's skull, which was found at Gloucester after the year 1630, with some large teeth, some five, others seven inches in compass.

Observations towards composing a Natural History of Mines and Metals. By Dr. Nicholls.

Of all the substances concurring to form the terrestrial globe, Iron probably bears the greatest share; as it not only abounds in most kinds of stone, showing itself in varieties of crocus, all which gain a more intense colour by fire; but also enters greatly into the composition of common clay; as may be judged from the similitude of colour between clay and dry iron ore; from the easy vitrification of clay; from the resemblance between clay so vitrified and the clinkers of iron; from its deep red colour after calcination; and, lastly, from its yieding pure iron, by being burned with oil.

When most pure, the ore is found under three different appearances. 1. A rich dry ore, whose scrapings exactly resemble an alkohol martis: this kind of iron ore has very nearly the colour of common clay. 2. A rich iron ore, with part of the wall of the load formed by a concretion of yellow

crystals. In this stone the iron radiates from points forming segments of spheres, and where these spheres leave any interstices is found a crocus or ochre. 3. A stone of iron of the kind used for burnishing plate; it is of the species of the hæmatites. Both these last stones scrape into a deep crocus. And from the second instance we may conjecture, that the yellow colour in crystals arises from a crocus entangled with the stony salts.

The metallic substance found in Cornwall, and from which these islands are supposed to take their name, is TIN. It is never found but as an ore; whereas gold is never found but as a metal, at least its ore is unknown, and all other metals are found sometimes as a metal, and sometimes as an ore. Tin always shoots into crystals, which are of different magnitudes, from two ounces in a single crystal, to such as escape our sight. These crystals are for the most part interspered in loads of other substances. As, 1. Tin crystals interspersed in a load of a kind of clay, in which is observable a considerable quantity of red ochre. 2. A kind of hard iron stone, in which are very small crystals of tin. 3. Somewhat larger crystals, interspersed in a dry red ochre. 4. Tin crystals, interspersed with spar stone and a sort of marl. 5. Larger crystals, interspersed in a kind of clay and red ochre. When 100 sacks of the load, each containing more than a Winchester bushel, yield one gallon of clean ore, the load is esteemed very well worth working. Sometimes these crystals are so collected into one mass as to form loads of pure tin ore, and so large as to yield to the value of 100*l.* every 24 hours.

The crystals seem to be the heaviest bodies the earth produces, except quicksilver and real metals. Their specific gravity is to water, as 90½ to 10; to rock crystal in water, as 90½ to 26; to diamond, as 90½ to 34; and to pure malleable tin, as found by repeated trials, as 90½ to 78; from whence appears the possibility of what some miners affirm, viz. that a cubic inch of some tin ores will yield more than a cubic inch of metal.

A new Apparent Motion discovered in the Fixed Stars; its Cause assigned; the Velocity and Equable Motion of Light deduced. By the Rev. JAMES BRADLEY.

MR. MOLYNEUX's apparatus was completed, and fitted for observing, about the end of November, 1725, and on December 3. following, the bright star in the head of Draco,

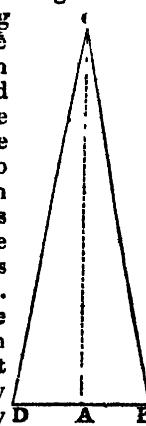
marked γ by Bayer, was for the first time observed, as it passed near the zenith, and its situation carefully taken with the instrument. The like observations were made on the 5th, 11th, and 12th days of the same month, and there appearing no material difference in the place of the star, a further repetition of them at this season seemed needless, it being a part of the year when no sensible alteration of parallax in this star could soon be expected. It was chiefly therefore curiosity that tempted Mr Bradley, being then at Kew, where the instrument was fixed, to prepare for observing the star on Dec. 17., when having adjusted the instrument as usual, he perceived that it passed a little more southerly this day than when it was observed before. This sensible alteration the more surprised them, as it was the contrary way from what it would have been, had it proceeded from an annual parallax of the star; about the beginning of March, 1726, the star was found to be 20″ more southerly than at the time of the first observation. It now, indeed, seemed to have arrived at its utmost limit southward, because in several trials made about this time, no sensible difference was observed in its situation. By the middle of April it appeared to be returning back again towards the north; and about the beginning of June it passed at the same distance from the zenith as it had done in December, when it was first observed.

A nutation of the earth's axis was one of the first things that offered itself on this occasion; but it was soon found to be insufficient; for though it might have accounted for the change of declination in γ Draconis, yet it would not at the same time agree with the phenomena in other stars: particularly in a small one almost opposite in right ascension to γ Draconis, at about the same distance from the north pole of the equator; for, though this star seemed to move the same way, as a nutation of the earth's axis would have made it, yet changing its declination but about half as much as γ Draconis in the same time, as appeared on comparing the observations of both made on the same days, at different seasons of the year, this plainly proved that the apparent motion of the stars was not occasioned by a real nutation, since if that had been the cause, the alteration in both stars would have been nearly equal.

When the year was completed, he began to examine and compare his observations; and having pretty well satisfied himself as to the general laws of the phenomena, he then endeavoured to find out the cause of them. He was already

convinced, that the apparent motion of the stars was not owing to a nutation of the earth's axis. The next thing that offered itself was an alteration in the direction of the plumb-line, with which the instrument was constantly rectified; but this, upon trial, proved insufficient. He then considered what refraction might do; but here also nothing satisfactory occurred. At last he conjectured, that all the phenomena hitherto mentioned, *proceeded from the progressive motion of light and the earth's annual motion in its orbit.* For he perceived that, if light was propagated in time, the apparent place of a fixed object would not be the same when the eye is at rest, as when it is moving in any other direction, than that of the line passing through the eye and object; and that, when the eye is moving in different directions, the apparent place of the object would be different.

Mr. B. considered this matter in the following manner. He imagined C A to be a ray of light, falling perpendicularly on the line B D; then if the eye be at rest at A, the object must appear in the direction A C, whether light be propagated in time or in an instant. But if the eye be moving from B towards A, and light be propagated in time, with a velocity that is to the velocity of the eye as C A to B A; then light moving from C to A, while the eye moves from B to A, that particle of it, by which the object will be discerned, when the eye in its motion comes to A, is at C when the eye is at B. Joining the points B C, he supposed the line C B to be a tube, inclined to the line B D, in the angle D B C, of such a diameter, as to admit of but one particle of light; then it was easy to conceive, that the particle of light at C, by



which the object must be seen when the eye, as it moves along, arrives at A, would pass through the tube BC, if it is inclined to BD in the angle DBC, and accompanies the eye in its motion from B to A; and that it could not come to the eye, placed behind such a tube, if it had any other inclination to the line BD. If instead of supposing CB so small a tube, we imagine it to be the axis of a larger; then for the same reason, the particle of light at C could not pass through that axis, unless it is inclined to BD, in the angle CBD. In like manner, if the eye moved the contrary way from D towards A, with the same velocity, then the tube must be inclined in the angle BDC. Although, there-

fore, the true or real place of an object is perpendicular to the line in which the eye is moving, yet the visible place will not be so, since that must be in the direction of the tube; but the difference between the true and apparent place will be, cæteris paribus, greater or less, according to the different proportion between the velocity of light and that of the eye. So that if we could suppose that light was propagated in an instant, then there would be no difference between the real and visible place of an object, though the eye were in motion; for in that case, AC being infinite with respect to AB, the angle ACB, the difference between the true and visible place, vanishes. But if light be propagated in time, which will readily be allowed by most of the philosophers of this age, then it is evident from the foregoing considerations, that there will be always a difference between the real and visible place of an object, unless the eye is moving either directly towards or from the object. And in all cases, the sine of the difference between the real and visible place of the object will be to the sine of the visible inclination of the object to the line in which the eye is moving, as the velocity of the eye to the velocity of light.

It is well known, that Mr. Romer, who first attempted to account for an apparent inequality in the times of the eclipses of Jupiter's satellites, by the hypothesis of the progressive motion of light, supposed that it spent about 11 minutes of time in its passage from the sun to us; but it has since been concluded by others, from the like eclipses, that it is propagated as far in about seven minutes. The velocity of light, therefore, deduced from the foregoing hypothesis, is, as it were, a mean between what had at different times been determined from the eclipses of Jupiter's satellites.

These different methods of finding the velocity of light thus agreeing in the result, we may reasonably conclude, not only that these phenomena are owing to the causes to which they have been ascribed; but also, that light is propagated, in the same medium, with the same velocity after it has been reflected, as before: for this will be the consequence, if we allow that the light of the sun is propagated with the same velocity, before it is reflected, as the light of the fixed stars. And this will scarcely be questioned, if it can be made appear that the velocity of the light of all the fixed stars is equal, and that their light moves, or is propagated, through equal spaces in equal times, at all distances from them: both which points appear to be sufficiently proved from the apparent alteration of the declination of stars of different lustre; for that is not

sensibly different in such stars as seem near together, though they appear of very different magnitudes. And whatever their situations are, if we proceed according to the foregoing hypothesis, the same velocity of light is found from his observations of small stars of the fifth or sixth, as from those of the second and third magnitude, which in all probability are placed at very different distances from us.

The parallax of the fixed stars is much smaller than has been hitherto supposed by those who have pretended to deduce it from their observations. Mr. B. thinks he may venture to say, that in either of two stars it does not amount to 2″. He thinks that if it were 1″ he should have perceived it in the great number of observations he made, especially of γ Draconis; which agreeing with the hypothesis, without allowing any thing for parallax, nearly as well when the sun was in conjunction with, as in opposition to, this star, it seems very probable that its parallax is not so great as one single second; and, consequently, that it is above 400,000 times farther from us than the sun.

Observations made in a Journey to the Peak in Derbyshire. By Mr. J. Martyn, F.R.S.

The Peak in Derbyshire is famous for seven places, which our ancestors have deemed wonders: 1. Chatsworth, a magnificent seat of His Grace the Duke of Devonshire; 2. Mamtor; 3. Elden-hole; 4. The ebbing and flowing well; 5. Buxton-well; 6. Peak's hole; and, 7. Pool's hole.

The first being a work, not of nature, but art, does not come within the design of this account.

Mam-tor is a huge precipice facing the east, or south-east, which is said to be perpetually shivering, and throwing down great stones on a smaller mountain below it; and yet, neither the one increases, nor the other decreases in size. This mountain is chiefly composed of a sort of slate-stone, called in that country black shale, and great stone. The nature of the black shale is such, that though it be very hard before it is exposed to the air, yet it is afterwards very easily crumbled to dust.

Elden-hole is a huge perpendicular chasm of unknown depth. Mr. Cotton says, that he sounded 884 yards, and yet the plummet drew. But he might easily be deceived, unless his plummet was of a very great weight; for otherwise the weight of a rope of that length, would be so great, as to make the landing of the plummet scarcely perceivable. Be that as

it may, the depth is, doubtless, very considerable; and as we have no where in England so good an opportunity of searching the bowels of the earth to so great a depth, it is extraordinary no curious person has ever had the courage to venture down. It is said, indeed, that a poor fellow was hired to be let down with a rope about his middle, 200 yards; and that he was drawn up again out of his senses, and died a few days after. But probably if any intelligent and prudent person was to be let down in a proper machine, he would not be much in danger, and his fatigue would be very inconsiderable.

The ebbing and flowing well is far from being regular, as some have pretended. It is very seldom seen by the neighbours themselves; and Mr. M. waited a good while at it to no purpose.

Buxton-well has been esteemed a wonder, on account of two springs, one warm and the other cold, rising near each other. But the wonder is now lost, both being blended together. The spring which is now used for bathing appears to be 32½ degrees of one of Mr. Hauksbee's thermometers warmer than the common spring-water there, or 82 of Fahrenheit. The spring-water kept the spirit of wine at 41, the Bath water raised it to 80½.

Peak's hole and Poole's hole are two remarkable horizontal openings under mountains, the one near Castleton, the other just by Buxton. They seem to have owed their origin to the springs which have their current through them. It is easy to imagine, that when the water had forced its way through the horizontal fissures of the strata, and had carried the loose earth away with it, the loose stones must of course fall down; and that where the strata had few or no fissures, they remained entire, and so formed those very irregular arches so much wondered at in these places; which seems a more probable origin than what others have hitherto proposed. The three rivers, as they are commonly called, in Peak's hole, are only some parts of the cave deeper than the rest, and receiving all their water from the spring which comes from the farther end of the cave. The water which passes through Pool's hole is impregnated with particles of lime-stone, and so has incrusted almost the whole cave in such a manner, that it appears like one solid rock.

An Account of the Imperial Salt Works of Sóowár, in Upper Hungary. By Ernest Bruckman, *M.D.*

Sóowár is a Hungarian word, signifying in German saltburg, composed of *so*, i. e. salt, and *wa*, that is, burgh or town, where the salt-works are. Eper, a city of the county of Saár, is entirely peopled with officers of the excise, and miners or wood-cutters, and is situated on the summit of a little hill.

We first descended into the works down the well by a rope, seated on leathern dogs (as they term it), about 10 fathoms deep; after which we again descended 100 fathoms, by clinging perpendicularly against the wall and sides of the wells; and having again continued our journey under ground in the salt-work, we then found ourselves in the cuts, and saw all the alleys cut in the finest rock-salt; in the midst of which there were here and there some veins of a dark grey flint. The miners work to cut this rock-salt, which they draw up by a rope, and put it into a reservoir, where they cleanse it with salt-water. They boil it afterwards with the same water, till it becomes of the consistence of crystal, and then put it into vessels, which contain about 268 lb. weight each.

As to the vegetable or fossil-salt, it is extremely white and transparent; and in such plenty in the salt-works of the county of Marmar, near Transylvania, where there are large entire mountains of salt, that one might furnish the whole world for quantity; as also, because as soon as cut, it grows again anew in a very short time. They break and cut it; though it appear at first black, yet in pounding it becomes extremely white; and so it is with that used in Hungary, for they send all the salt of Sóowár into foreign countries. You find almost in every inn two stones like to those used to make mustard, between which they pound and break that sort of rock-salt; and one finds also in their stables large pieces of that mineral, which the cattle lick at pleasure.

But to return to the salt of Sóowár, there are sometimes in the cuts alleys of rock-salt, of the most delicate blue and yellow colours. We observed that, that of the first colour, being exposed to the sun for some days, lost entirely all that beautiful ultra-marine, and became white as the other rock-salt; which did not happen to the yellow, which preserved its colour; but when pounded both together, the salt was neither blue nor yellow, but produced a salt extremely white.

But what is most curious and remarkable in these subter-

raneous fosses are the flowers of salt, which grow as the beard of a goat, with this difference only, that these are much whiter, and much finer. One cannot enough admire these vegetables, yet one cannot find them in all the cuts, nor at all times, but they appear and grow according to the temperature of the seasons, which in those parts is very wholesome, and without any thing noxious. These sorts of plumes of salt are very brittle; they melt also in moist places, and dissolve into an evaporated oil, but are nevertheless the most pure salt, the finest, the most acid, the most white, and most beautiful; so that it is not without reason they have given it the name of flower of salt.

Magnetical Observations and Experiments. By SERVINGTON SAVERY, *Esq. of Shilston.*

THE observations made by Mr Savery are as follow: —

That the two opposite parts of a loadstone attract most vigorously, and are called its poles. The middle between its two poles does not attract at all, and may be called its equinoctial; and from either pole to the middle, the attracting force gradually abates.

That there is no difference, that he could find, between the force of strength of attraction and that of repulsion in the same pole of any loadstone or magnet, unless when a small one approaches so near to a large one as to have its polarity more or less diminished by it.

These properties convince him, that there is no such thing in nature as magnetical attraction without polarity, which is constituted of attraction and repulsion; and these two powers being always equally strong in the same pole of every magnet, he thinks it a plain contradiction, to say this or that loadstone has a strong attraction, but a weak polarity or direction.

That no interposed body whatever, unless it be magnetical, though the most solid in nature, was ever known in the least to impede or divert any of the effects of a magnet; but it is always found to attract magnetical bodies full as powerfully at the same distance, as if nothing at all were between.

That every frustum of a loadstone is an entire or perfect loadstone, having in itself both poles as the whole stone had; and that the poles in each frustum have their direction, as near as the figure of it will admit, in the same parallel line in which they were directed both in it and the whole stone, be-

fore it was separated: for the polarity of every fragment is usually, if not always, before they are separated, parallel to that of the whole stone, and, consequently, to that of each other: and if ever it is found otherwise, Mr. S. thinks that loadstone wants of perfection. So that the parts of any magnet, when cut in two transversely, or perpendicular to its axis, become complete magnets, having each their poles and axis parallel to the whole magnet; and that, whether the two parts are equal or unequal. And the sum of the weights of iron, lifted by the two parts separately, is greater than the single weight lifted by the whole magnet.

That all magnetical attraction (as also repulsion) is mutual; for iron or steel attracts the loadstone, as that does iron or steel, and they also each other.

That every loadstone communicates virtue to iron or steel, not only by contact, but even by their approach within its attractive sphere, more or less as nearer to, or farther from, its body; and likewise its poles, also according to the shape, size, and specific virtue, and figure of the iron or steel, and their proportion of magnitude to each other; and that a small magnet communicates nearly as much virtue as a large one. Some authors write, that the loadstone loses none of its virtue by communicating of it to iron or steel, which Mr. S. doubts the truth of, especially if the stone is small in proportion to the steel, in which case he has known touched steel to lose considerable virtue.

That steel is not only more receptive, but more retentive of magnetism, than common iron; and iron or steel hammered hard, than the same while soft; but steel hardened by quenching, than either of them.

That such iron or steel as has magnetic virtue communicated to it, also communicates it to other iron or steel after the same manner as a loadstone does. Which virtue, after ever so many communications, is, as to its nature, perfectly the same with that of the stone itself, having both poles, and will touch other steel, and that a compass, as well as the loadstone itself, and as vigorous, if properly used.

That every loadstone, within its attractive sphere, has a power to keep one piece of iron suspended to another, especially if that to which it is suspended is the larger, and their ends be bright and clean, where they touch each other; and if the suspended iron is not too heavy, the other will draw it up from either pole of the naked loadstone actually touching it, and will also keep it suspended, till at a considerable distance; but will not draw it off in such manner from the

armour of unarmed stone, if the armour and iron are both of them bright and clean at their contact. Hence it must follow, —

That an armed loadstone can lift more with either of its poles, used singly, than the same can lift naked: that not only steel or iron, regularly touched, but also oblong iron void of permanent virtue, will perform all that any loadstone can, though not with the same degree of power: for either of them will attract, keep one piece of iron suspended to another, and communicate some degree of permanent polarity to steel well hardened, as Mr. S. has experienced, and also to an iron wire.

That, of a soft iron bar void of fixed polarity, as soon as it is in an erect position, the higher part from the middle upward becomes a north pole in north, or a south pole in south magnetic latitude. And, e contra, the lower part from the middle downward becomes a south pole in north, and a north pole in south latitude: but as soon as the bar is inverted, the polarity is shifted in it, and in north latitude the end newly placed upward becomes the north pole, though it was a south one immediately before, and the other end the south pole, though it was its north one just before. The case is the same, if such a bar is placed horizontally in or near the magnetical meridian; for the end directed toward the north will constantly be a south pole, and that which is directed toward the south a north one; and as soon as the ends of the bar are shifted, the polarity, in respect of the bar, is shifted also, but not in respect of the earth, for which reason this virtue is called transient, and is communicated by the earth's central magnet in such manner as other loadstones are said to do.

That if a bar of iron or steel, not having the least degree of fixed virtues, be placed in any position, except at or near to a right angle with the magnetical line, it will not only for the present receive a transient polarity, but if it remain so long, the said polarity will gradually become fixed or permanent, more or less, according to the hardness or softness of the bar, and the time it has remained in that position, and the angle its length makes with the magnetical line, and the proportion of the length to its magnitude, the longest, cæteris paribus, usually receiving most virtue; and sometimes when all these advantages concur, the polarity will be sensibly permanent in a little time, and not require a very long time to be rendered pretty strong.

That by placing the said bar afterwards in the same position,

only with its ends shifted, it will gradually lose its gained magnetism, and at length have its polarity changed.

That magnetism not only in touched iron and steel, but also in the loadstone itself, is soon destroyed by fire.

That though fire destroys fixed magnetism in steel or iron, yet if they are set to cool in an erect position, or rather in the direction of the magnetical line, they will gain more or less fixed virtue by the time they are cold; but especially steel heated to a seasoning height, and in that position cooled suddenly under water.

That while a piece of iron of some magnitude is held at one pole of a loadstone, it will increase the attraction of the other pole thereof, and enable it to lift somewhat more.

That if either pole of a magnet, large enough, touch one end of an oblong piece of steel, not too large and long for the magnet easily to act on, it will transmit its own virtue to the other end of the steel which is farthest off, and make it a pole of its own kind; while the end that touches the stone has virtue of the contrary pole: but the virtue usually is not so strong in the end which is untouched as in that which is.

That a needle first equally poised, then touched and put to oscillate on its pivots in the magnetical meridian, will in north latitude have its north end (*i. e.* its south pole) depressed until it directs to the north-attracting point of the central magnet; where, after several oscillations, it will at last rest: and in south latitude the south end will be depressed after the same manner.

An Account of the different Sorts of Paper of the Ancients. By the Hon. Sir John Clerk, *F.R.S.*

Of the several sorts of charta used for writing, the most ancient were made of barks of trees, or skins, or were such as are called pugillares. The oldest were of the inner bark of trees, called liber in Latin, whence a book had the name of liber; but very little of this sort is now in being, except the Egyptian papyrus may be accounted one species of it.

The papyrus was made of a plant having many pelliceous tunicles, as Pliny informs us, which were separated from one another by a needle, and then glued again together, to give them a strength and firmness sufficient to retain what might be written on them. Alexandria was the place most eminent for this manufacture. There are some fragrants of this sort still extant in libraries, particularly the famous manuscript .'Mark's Gospel at Venice.

The chartæ membranaceæ are made of the skins of animals, dressed either like our glove-leather, or modern parchment. The first sort was commonly used by the Jews for writing the law of Moses on it, and from the rolling up of these skins, comes the word volumen. But the skins which Varro and Pliny say were first made by Eumenes king of Pergamus, were in more common use: however, Eumenes, who is related by these authors to have made them in opposition to Ptolemy king of Egypt, who had forbidden the exportation of the papyrus from his dominions, does not seem to be the inventor of the chartæ membranaceæ; since Herodotus, who lived long before his time, informs us, that the Ionians and other nations used to write on goat and sheep skins. Josephus also tells us, that the Jews sent their laws written on skins in letters of gold to Ptolemy; by which it seems as if the writing on skins was no new thing at that time among the Jews.

The use of the pugillares was also very ancient, being mentioned by Homer, and among the Latins by Plautus. They were made of all sorts of wood, ivory, and skins, covered over with wax. They were likewise of several colours, as red, yellow, green, saffron, white, and others. Being waxed over, any thing was easily written on them by the point of the stylus, and as easily rubbed out, and altered by the flat part of it. Sometimes these pugillares were made of gold, silver, brass, or lead, and then there was a necessity of an iron stylus to write or cut the letters on them.

The diptychs and triptychs that were covered with wax served only for common occurrences; the other sorts received every thing else that was written on chartæ or membranæ, and were sometimes called by the Greeks palimpsestæ, from the rubbing out of the letters on them.

The chartæ linteæ, and bombycineæ, which were made of linen or cotton, were of much later date; and from these we learned to make the paper now in use of linen rags, an invention probably of about 600 years standing.

Writing was practised on all these chartæ with a reed, and afterwards with a pen, except on the pugillares. These reeds grew on the banks of the Nile; the Greeks also used reeds imported from Persia for the same purpose. Calami argentei are also mentioned for writing.

Their letters were formed with liquors of various colours, but chiefly black, thence called atramentum. It was sometimes made of the blood of the cuttle-fish, sometimes of soot. Apelles composed a black of burnt ivory, which was called

elephantinum. They had ink also from India, of an improved composition, as Pliny says.

The titles of their chapters and sections were written in red or purple: hence the titles of the Roman laws are called rubricæ. Their purpura was an exceedingly bright red, or crimson, much in vogue with the Byzantine writers; which was a liquor made of the murex boiled, and its shell very finely powdered; or, as Pliny relates, of the blood of that fish. Almost all the ancient emperors wore this colour; their names were painted in it on their banners; and they frequently wrote with it, and wore it. This colour was often the distinction of a Roman magistrate, and to put on the purple, was the same thing as to assume the government.

The children of the emperors, and such as had a prospect of rising to the throne, and their guardians, sometimes wrote with green; gold also was employed for the like purpose.

Conjectures concerning Stars which sometimes appear and disappear; and on Saturn's Ring. By PETER LEWIS DE MAUPERTUIS.

THE consideration of the figures which fluids may take, according to the different ratio of gravity to the centrifugal force, suggested to M. Maupertuis, that probably the planets have such forms; since for this there is only necessary a swifter motion round the axis, or a less density of matter: for, though few planets, that we know of, come sufficiently near a spheroidal figure, why may we not admit of other forms, either about other suns, or even our own? these lentiform planets would never be seen by us, either by reason of their distance, or because they would be in the plane of the ecliptic, or in a plane somewhat inclined to it, to which plane their axis of revolution would be perpendicular, or nearly so; for in this situation they could not be seen from the earth.

And why might not such a variety of forms obtain among the fixed stars? especially, since it is very probable that they revolve round their axis, like our sun. There are, probably, lentiform fixed stars in the heavens; and probably they are surrounded with very eccentric planets or comets, which, since they are not fixed in the plane of the equator, when they approach the perihelion, disturb the direction of the star's axis; and then the star, which by reason of its situation now disappears, appeared; or that which appeared before, now disappears. And so a reason might be assigned, why some stars seem to appear and disappear alternately.

But if in any system a comet with a tail move near some powerful planet, what will be the consequence? why, the matter emitted from the body of the comet will be attracted round the planet; and by the comet's sending out new matter, or a sufficient quantity being already emitted, there will arise a continual flux of matter round the planet; and though the column, emitted from the comet, may at first be either of a cylindrical, conical, or any other form, yet its centrifugal force, with the gravities arising both from the planet and from the effluent matter, will always render it broader and thinner; and thus a reason might be assigned for Saturn's ring, the most surprising phenomenon in nature.

And while the tail of the comet would furnish the planet with such a ring, the comet itself might probably be attracted, if at a due distance, and become a new satellite to the planet; and thus, probably, several comets have furnished out both Saturn's satellites and his ring; for it is not likely that Saturn's ring is owing to the effluvia of one comet, since it projects a shadow on his disk; whereas the matter of the tails of comets is so rare, that the stars may be seen to shine through it. Saturn's ring, therefore, seems to consist of the tails of several comets, whose matter is become more dense on account of his attraction.

It is evident that a planet may acquire satellites, and yet not a ring; for all comets have not a tail; and if a comet without a tail be attracted, it will furnish the planet a satellite without a ring.

The great Sir Isaac Newton has concluded, that the vapours of comets are dispersed among the planets; nay, he reckoned this communication necessary, in order to repair the loss of liquid matter. And Dr. Halley and Mr. Whiston are of opinion that both comets and their tails cause considerable changes in the planets, as a variation in their poles, or deluges, and conflagrations; but comets may possibly produce more benign effects, and even sometimes supply the planets with useful and surprising things.

On the Nature of Intermitting and Reciprocating Springs By Mr. Joseph Atwell, F. R. S.

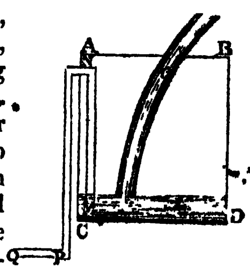
The following conjectures on the subject of intermitting and reciprocating springs were suggested to Mr Atwell by the phenomena of a particular fountain he had seen, the winter before:—

The spring is situated at one end of the town of Brixam, near Torbay, in Devonshire, and is known by the name of Laywell. It is a long mile distant from the sea, on the north and north-east side of a ridge of hills, lying between it and the sea, and making a turn or angle near this spring. It is situated in the side of those hills, near the bottom, and seems to have its course from the south-west towards the north-east. There is a constantly running stream which discharges itself near one corner into a basin, about eight feet in length, and $4\frac{1}{2}$ in breadth; the outlet of which is at the farthest end from the entrance of the stream, about three feet wide, and of a sufficient height. On the outside of the basin are three other springs, which always run, but with streams subject to a like regular increase and decrease with the former They seem indeed only branches of the former, or rather channels discharging some parts of the constantly running water, which could not empty itself all into the basin; and therefore when, by means of the season, or weather, springs are large and high, on the flux or increase of this fountain, several other little springs are said to break forth, both in the bottom of the basin and without it, which disappear again on the ebb or decrease of the fountain. All the constantly running streams put together, at the time that he saw them, were more than sufficient to drive an overshot mill; and the stream running into the basin might be about half of the whole.

Mr. Atwell made a journey purposely to see it, in company with a friend. When they came to the fountain, they were informed that the spring had flowed and ebbed about 20 times that morning; but had ceased doing so about half an hour before they came. On their return to it, a man, who was still at work near it, said that it began to flow and ebb about half an hour after they went away, and had done so 10 or 12 times. In less than a minute, they saw the stream coming into the basin, and likewise the others on the outside of the basin begin to increase and to flow with great violence; on which the surface of the water in the basin rose an inch and a quarter perpendicularly, in near the space of two minutes; immediately after which, the stream began to abate again to its ordinary course; and in near two minutes' time the surface was sunk down to its usual height, where it remained near two minutes more. It then began to flow again as before; and in the space of 26 minutes flowed and ebbed five times; so that, an increase, decrease, and pause, taken together, were made in about five minutes, or a little more.

Mr. Atwell imagines them to be occasioned by two streams or springs, one of which passing through two caverns or natural reservoirs with syphons, meets with the other stream in a third reservoir, without a syphon; where, being joined, they come out of the earth together.

The supposition of reservoirs and syphons in the bowels of the earth has been made by others. But whoever has seen the Peak of Derbyshire, the hilly parts of Wales, or other countries, must be satisfied that they abound with caverns of many sorts. Some of them are dry, others serve only for passages, or channels to streams, which run through them; and a third sort collect and hold water, till they are full. They must also have observed, that there are sometimes narrow passages, running between the rocks which compose the sides, and going from one cavern to another. Such a passage, of whatever shape or dimensions, how crooked and winding soever in its course, if it be but tight, and runs from the lower part of the cavern, first upwards to a less height than that of the cavern, and then downwards below the mouth of the said passage, will be a natural syphon.



A natural reservoir then, A B C D, with such a natural syphon, M N P, may be supposed. Let a feeding stream enter it, near the top, at O. The cavern must contain all the water which comes in at O, till it is filled to the top of the syphon at N. Then the syphon beginning to play, and being supposed always to discharge more water than comes in by the feeding-stream at O, will empty the cavern, till the water is sunk in it below the mouth of the syphon at M; when it must stop, till the cavern is filled, and the syphon runs again as before. If the water discharged by such a syphon, M P, be brought out of the earth by a channel, P Q, the water will flow out of the earth, and stop alternately, making an intermitting fountain at Q. By this plain and easy contrivance, several of the flowing and ebbing springs, observed by the naturalists, may probably be explained; and even a much greater variety of them than is hitherto known.

Experiments to prove the Existence of a Fluid in the Nerves. By Alexander STUART, *M.D. F.R.S.*

Exper. 1.—DR STUART suspended a frog by the fore legs in a frame, leaving the inferior parts loose; then the head being cut off with a pair of scissors, he made a slight push perpendicularly downwards, on the uppermost extremity of the medulla spinalis, in the upper vertebra, with the button-end of the probe, filed flat and smooth for that purpose; by which all the inferior parts were instantaneously brought into the fullest and strongest contraction. This he repeated several times, on the same frog, with equal success; intermitting a few seconds of time between the pushes, which, if repeated too quick, made the contractions much slighter.

Exper. 2.—With the same flat button-end of the probe he pushed slightly towards the brain in the head, on that end of the medulla oblongata appearing in the occipital hole of the skull; on which the eyes were convulsed. This also he repeated several times, on the same head, with the same effect.

Exper. 3.—He tied a piece of fine twine, or thread, parallel to the crural artery, vein, and nerve of a dog; and made a ligature on them, and on the parallel twine, above and below, at the distance of about four inches; then he cut beyond the ligatures above and below, so as to take out the vessels and nerve, with the parallel twine, in one bundle; and laying them on a board, both the artery and vein contracted immediately, and were shortened to almost one half of the natural length which they had in the body, viz. to 2½ inches, whereas the nerve remained uncontracted, at its natural length, and commensurated to the parallel twine of four inches, as before it was cut out of the body.

By which it appears that the proportion of the blood-vessels in their completest contraction, to the same in a state of extension, and to the nerves at their constant and natural length, is nearly as five to eight; or, which is the same thing, any given section of a blood-vessel, cut out and left to itself, is capable of contracting, so as to lose ⅜ parts of its length.

The first two experiments show, that the brain and nerves contribute to muscular motion, and that in a very high degree.

The third experiment makes it as plain, that what they contribute in muscular motion cannot arise from, or be owing to, elasticity, which they have not.

What remains, therefore, but to conclude, that the action of

the nerves in muscular motion is owing to the fluid they contain, by whatever name we may choose to call it.

Experiments on the Friction of Pulleys. By the Rev. J. T. Desaguliers.

The first experiment was made with a tackle of five brass sheevers in iron frames or blocks; that is, three sheevers in the upper block, and two in the lower. The sheevers were five inches in diameter, the pins half an inch, and the rope three quarters. Having made an equilibrium, by hanging one hundred and a quarter at the lower block, and a quarter of a hundred at the running rope, he added 17½ pounds before the power could go down and raise the weight.

Two hundred and a half being balanced by half a hundred, the addition of 28 lb. made the power raise the weight.

In the experiment 17½ pounds exceed by 4¼ pounds the sum of the frictions deduced from the theory. But in the second experiment, 28 pounds exceed the sum of the friction but one pound.

The reason of this appeared to be, that the rope at first was too large for the cheeks that held the sheevers; but in the second experiment, where the rope was more stretched, it was somewhat diminished in diameter, and so brought off from rubbing so hard against the cheeks.

Of a Beaver. By C. Mortimer, M.D. R.S.S.

In the Memoirs of the Academy of Sciences at Paris, for the year 1704, is an extract of a letter from M. Sarrasin, the king's physician in Canada, concerning the dissection of a beaver. He says, the largest are three or four feet long, and about a foot or 15 inches broad in the chest, and at the haunches; that they commonly weigh about 50 lb.; that they usually live to the age of 20 years: but Francus says, they live 30 or 40 years, and that he heard of a tame one being kept 78 years: perhaps the European may generally be longer lived than the American.

Dr. Sarrasin says further, that a great way north these animals are very black, though there are some white ones to be seen; those in Canada are commonly brown; but their colour grows lighter, as they are found in more temperate countries; for they are yellow, and even almost of a straw-colour in the country of the Illinois and Chaovanons.

As to their manner of living; they choose a low level

ground, watered with a small rivulet, that it may be easily overflowed, which they do by making dams across it: they make these dams by thrusting down stakes of five or six feet long, and as thick as one's arm, pretty deep into the ground; these they will wattle across with tender pliable boughs, and fill up the spaces with clay, making a slope on the side against which the water presses, but leaving the other perpendicular. They make their houses after the same manner; the walls are upright, two feet thick, and at top in form of a dome; they are usually oval, five or six feet long on the inside, and near as broad, being sufficient to lodge eight or 10 beavers, and two or three stories high, which they inhabit as the water rises or falls.

Sometimes they build several houses near together, which communicate with one another. He says there are some beavers called terriers, which burrow in the earth: they begin their hole at such a depth under water as they know that the water will not freeze so deep; this they carry on for five or six feet, and but just large enough for them to creep through; then they make a bathing-place three or four feet every way; from whence they continue the burrow, always ascending by stories, that they may lodge dry as the waters rise: some of these burrows have been found to be 100 feet long. They cover the places where they lie with weeds; and in winter they make chips of wood, which serve them for mattresses: they live on herbs, fruits, and roots in summer; but against winter they lay up a provision of wood: a stack of 25 or 30 feet square, and eight or ten high, is the usual quantity for eight or ten beavers; they only eat those pieces which are soaked in the water.

A female beaver was kept at Sir Hans Sloane's, in his garden, for about three months. She was but about half grown, not being above 22 inches long from the nose to the root of the tail; the tail eight inches long. She was very thick, paunch-bellied; the shape of the head, and indeed of the whole animal, except the tail, and hind feet, very much resembled a great over-grown water-rat.

Her food was bread and water; some willow-boughs were given her, of which she ate but little; but when she was loose in the garden, she seemed to like the vines much, having gnawed several of them from as high as she could reach quite down to the roots: she gnawed the jessamine likewise, but least of all some holly trees. When she ate, she always sat on her hind legs, and held the bread in her paws like a squirrel. When she slept, she commonly lay on her belly, with her tail

under her. In swimming, she held her fore-feet close up under her throat, and the claws closed, as when one brings the ends of one's thumb and of all the fingers close together, never moving her fore feet till she came to the shore, and endeavoured to get out. She swam with her hind feet only, which had five toes, and were webbed like those of a goose; the tail, which was scaly, and in form of the blade of an oar, served as a rudder, with which she steered herself, especially when she swam under water, which she would do for two or three minutes, and then come up to breathe; sometimes raising her nostrils only above water: she swam much swifter than any water-fowl, moving under water as swift as a carp. The hind legs being much longer than the fore, made her walk but slowly, or rather waddle like a duck, when on dry land; and if driven along fast, she could not run, but went by jumps, flapping her tail against the ground. Her excrements were always black, and very fetid; her urine turbid and whitish, and very strong-scented. She made no noise, except a little kind of grunting, when driven fast and angred. She seemed very brisk, and thrived well with the above-mentioned food, being turned into the fountain to bathe three or four times a week. She had one day convulsion fits, very like the epilepsy in men, from which she recovered soon, and was very well after them, till at last she was killed by a dog.

On the Cause of the General Trade Winds. By GEORGE HADLEY, *Esq. F.R.S.*

THAT the action of the sun is the original cause of these winds, it seems all are agreed; and that it effects them by causing a greater rarefaction of the air in those parts on which its rays, falling nearly perpendicular, produce a greater degree of heat there than in other places; by which means the air becoming specifically lighter than the rest round about, the cooler air will, by its greater density and gravity, remove it out of its place, and make it rise upwards. But it seems that this rarefaction will have no other effect than to cause the air to rush in from all parts, into the place where it is most rarefied, especially from the north and south, where the air is coolest, and not more from the east than the west, as is commonly supposed. So that, setting aside the diurnal motion of the earth, the tendency of the air would be from every side towards that part where the sun's action is most intense at the time, and so a north-west wind be produced in the morning, and a north-east in the afternoon, by turns, on this

side of the parallel of the sun's declination, and a south-west and south-east on the other side.

That the perpetual motion of the air towards the west cannot be derived merely from the action of the sun upon it, appears more evidently from this: if the earth be supposed at rest, that motion of the air will be communicated to the superficial parts, and by little and little produce a revolution of the whole the same way, except there be the same quantity of motion given the air in a contrary direction in other parts at the same time: which is hard to suppose. But if the globe of the earth had before a rotation towards the east, this by the same means must be continually retarded: and if this motion of the air be supposed to arise from any action of its parts on each other, the consequence will be the same. For this reason it seems necessary to show how these phenomena of the trade winds may be caused, without producing any real general motion of the air westwards. This will readily be done by taking in the consideration of the diurnal motion of the earth: for let us suppose the air in every part to keep an equal pace with the earth in its diurnal motion; in which case there will be no relative motion of the surface of the earth and air, and consequently no wind; then by the action of the sun on the parts about the equator, and the rarefaction of the air thence proceeding, let the air be drawn down thither from the north and south parts

The parallels continually enlarge, as they approach to the equator, and the equator exceeds the tropics nearly in the ratio of 1000 to 917; consequently their difference in circuit is about 2083 miles, and the surface of the earth at the equator moves so much faster than the surface of the earth with its air at the tropics. From which it follows, that the air, as it moves from the tropics towards the equator, having a less velocity than the parts of the earth it arrives at, will have a relative motion contrary to that of the diurnal motion of the earth in those parts; which being combined with the motion towards the equator, a north-east wind will be produced on this side of the equator, and a south-east on the other side. These, as the air comes nearer the equator, will become stronger, and more and more easterly, and be due east at the equator itself, according to experience, by reason of the concourse of both currents from the north and south, where its velocity will be at the rate of 2083 miles in the space of one rotation of the earth or natural day, and above one mile and a third in a minute of time; which is greater than the velocity of the wind is supposed to be in the greatest storm, which, accord-

ing to Dr. Derham's observations, is not above one mile in a minute. But it is to be considered, that before the air from the tropics can arrive at the equator, it must have gained some motion eastward from the surface of the earth or sea; by which its relative motion will be diminished; and in several successive circulations may be supposed to be reduced to the strength it is found to be of.

Account of the Experiments made June 1. 1734, before several Members of the Royal Society, and others, on a Man, who suffered himself to be bitten by a Viper, or common Adder; and on other Animals likewise bitten by the same, and other Vipers. By Cromwell Mortimer, *M.D. Secr. R.S.*

William Oliver and his wife, from Bath, who follow the business of catching and selling vipers, offered themselves to be bitten by any viper that should be procured, trusting to the virtue of a remedy they had discovered, in trying a variety of things, when the woman was once accidentally bitten, and the usual known medicines, even the oil of vipers, had no effect in assuaging her pains especially of her breast on the same side as the hand in which she had received the wound. This remedy, which is only common oil of olives, and, from its use with salad, is commonly known by the name of *salad oil*, recommends itself not only for its efficacy, but also on account of its being readily attainable when accidents happen.

On the 1st of June, 1734, in the presence of a great number of persons, the said William Oliver was bitten by an old black viper, or adder, brought by one of the company, on the wrist and joint of the thumb of the right hand, so that drops of blood came from the wounds. He said that he immediately felt a violent pain and shooting from the wounds, both to the top of his thumb and up his arm, even before the viper was loosened from his hand; soon after he felt a pain, resembling that of burning, trickle up his arm; in a few minutes his eyes began to look red and fiery, and to water much: in less than half an hour, he perceived the venom seize his heart, with a pricking pain, which was attended with faintness and shortness of breath; on which he fell into violent cold sweats: in a few minutes after this, his belly began to swell, with great gripings and pains in his back, which were attended with violent vomitings and purgings. He said, that during the violence of these symptoms, his sight was gone twice, for several minutes at a time, but that he could hear all the while. He stated, that in his former ex-

periments he had never deferred making use of his remedy longer than when he perceived the effects of the venom reaching his heart; but this time, being willing to satisfy the company thoroughly, and trusting to the speedy effects of the oil, which had never failed him, when used in time, he forbore to apply any thing till he found himself exceedingly ill, and quite giddy.

About an hour and a quarter after he had been first bitten, a chafing-dish of glowing charcoal was brought in, and his arm, the clothes being stripped off, was held over it, as near as he could bear it, while his wife rubbed in with her hand the salad oil (which Dr. M. had procured and kept himself in his pocket, lest they should privately add any thing to it, having bought it by the name of Lucca oil). Turning his arm continually round, as if she would have roasted it over the coals; he said that the pain soon abated, but the swelling did not diminish much: most violent vomitings and purgings soon ensued, and his pulse became low and often interrupted: a glass or two of olive oil drank down, seemed to give him some ease.

Continuing in this dangerous condition, he was put to bed, as soon as one could be got ready for him, where his arm was again bathed with his remedy over a pan of charcoal set by the bed-side; but continuing to complain much of his back and belly, Dr. M. advised his wife to rub them likewise with salad-oil, heated in a ladle over the charcoal: which she did accordingly; on which he declared he found immediate ease, as if by some charm; and he had not above two or three retchings to vomit and stools afterwards, but made water plentifully, which was not discoloured. He then soon fell into a sound sleep, but was often interrupted by persons coming to see and enquire after him, till near 12 o'clock, from which time he slept continually to five or six next morning, when he awaked and found himself very well; but in the afternoon, on drinking some rum and strong beer, so as to be almost inebriated, the swelling returned with much pain, and cold sweats; which abated soon, on bathing the arm as before, and wrapping it up in brown paper soaked with oil.

June 3. the man's arm remained swelled, looked red, marbled with spots of yellow, but felt soft; and he had the perfect use of it, and even of his fingers, no pain or stiffness being left. He then caused a small spaniel dog to be bitten on the nose by a fresh viper: some oil was immediately applied hot, and rubbed well in, till all the hair of his nose was

thoroughly wet; the dog did not seem very uneasy; his nose only swelled a little; he ate soon after; his nose was bathed once more that evening; he was found very well next morning; but his nose was bathed again, to make sure of his cure; he remained perfectly well without any symptoms ensuing, and was alive and well a year after.

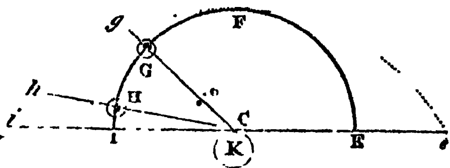
A pigeon was likewise bitten under the wing at the same time as the dog, but by a fresh viper. The oil was immediately applied hot, and rubbed well in, and the feathers of the wing were thoroughly wetted with it. This bird did not seem at all disordered with the venom, but ate soon after, and was found well the next morning, without any remarkable inflammation or swelling about the part. The hot oil was rubbed in again for two or three days, twice a day, and the bird continued well, so that the viper-catchers carried it with them out of town in triumph, having never before experienced the efficacy of their remedy on so small an animal; which, as it receives the same quantity of venom by a bite as a larger one, is more liable to die under it; and they kept it alive above three months, when they killed it and ate it.

They said that they had experienced their remedy to take effect on cows, horses, and dogs, 10 hours after being bitten; but that for themselves, who were frequently bitten in the fields, as they caught the vipers, they always carried a phial of salad oil along with them, that as soon as they perceived themselves wounded, they without any loss of time bathed the part with it; and if it was the heel, they wet the stocking thoroughly with it; if the finger, which happened oftenest, they poured some of it into the finger of their glove, which they immediately put on again, and thus never felt any further inconvenience from the accident, not even so much as from the sting of a common bee.

An Attempt to explain the Phenomenon of the Horizontal Moon appearing larger than when elevated several Degrees above the Horizon. By Dr. Desaguliers.

This apparent increase of the moon's diameter, which a telescope with a micrometer shows to be only apparent, is owing to the following early prejudice. When we look at the sky towards the zenith, we imagine it to be much nearer to us, than when we look at it towards the horizon: so that it does not appear spherical, according to the vertical section E F G H I, but elliptical, according to the section *e* F *g h i*

The sky thus seen strikes the eye in the same manner as the long arched roof of the isle of a cathedral church, or the ceiling of a long room.



This being premised, let us consider the eye at C, on the surface of the earth; and imagine C at the surface to coincide with K at the centre; to avoid taking into consideration that the moon is really farther from the eye when in the horizon, than when it is some degrees high. Now when the moon is at G, we consider it as at *g*, not much farther than G; but when it is at H, we imagine it to be at *h*, almost as far again. Therefore, while it subtends nearly the same angle as it did before, we imagine it to be so much larger, as the distance seems to us to be increased.

Dr. D. contrived the following experiment to illustrate this · he took two candles of equal height and size, and having placed one at the distance of six or eight feet from the eye, he placed the other at double that distance; then causing any unprejudiced person to look at the candles, he asked which was largest? and the spectator said they were both of a size; and that they appeared so, because he allowed for the greater distance. Then desiring him to shut his eyes for a time, Dr. D. took away the furthest candle, and placed another candle close by the first candle, and though it was as short again as the others, and as little again in diameter, the spectator, when he opened his eyes, thought he saw the same candles as before. Whence it is to be concluded, that when an object is thought to be twice as far from the eye as it was before, we think it to be twice as large, though it subtends but the same angle.— And this is the case of the moon, which appears to us as large again, when we suppose it as far again, though it subtends only the same angle.

Concerning a violent Hurricane in Huntingdonshire, Sept. 8. 1741. By Mr. Stephen Fuller.

This was the most violent hurricane of wind in these parts in the memory of man. Mr. F. happened to be at Bluntsham in Huntingdonshire, about 10 miles north-west of Cambridge. They were there in the midst of the hurricane. The morning, till half an hour after 11, was still, with very hard showers of rain. At half after 11 it began to clear up in the south,

with a brisk air, so that they expected a fine afternoon. The south-west cleared up too, and the sun shining warm drew them out into the garden. They had not been out above 10 minutes before the storm was seen coming from the south-west: it seemed not to be 30 yards high from the ground, bringing along with it a mist, rolling along with such incredible swiftness, that it ran about a mile and a half in half a minute. It began exactly at 12 o'clock, and lasted about 13 minutes, eight minutes in full violence: it presently uncovered the house; and some of the tiles, falling down to windward, were blown in at the sashes, and against the wainscot on the other side of the room; the broken glass was blown all over the room; the chimneys all escaped; but the statues on the top of the house, and the the balustrades from one end to the other, were all blown down. The stabling was all blown down, except two little stalls. All the barns in the parish, except those that were full of corn quite up to the top, were blown flat on the ground, to the number of about 60. The dwelling-houses escaped best; there was not above 12 blown down, out of near 100. The people all left their houses, and carried their children out to the windward side, and laid them down on the ground, and laid themselves down by them; and by that means all escaped, except one poor miller, who went into his mill to secure it against the storm, which was blown over, and he was crushed to death between the stones and one of the large beams. All the mills in the country are blown down.

Hay-stacks and corn-stacks are some of them blown away; others into the opposite corner of the field. The pigeons that were caught in it were dashed to pieces. Wherever it met with any boarded houses, it scattered their wrecks above a quarter of a mile to the north-east in a line: Mr. F. followed one of these wrecks; and about 150 yards from the building, he found a piece of a rafter many feet long, and about six inches by four, stuck upright two feet deep in the ground; and at the distance of 400 paces from the same building was an inch board, nine inches broad, and 14 feet long: these boards were carried up into the air; and some were carried over a pond above 30 yards; and a row of pales, as much as two men could lift, were carried two rods from their places, and set upright against an apple-tree.

Pales, in general, were all blown down, some posts were broken off close to the ground, others torn up by the stumps. The whole air was full of straw: gravel-stones, as large as the top of the little finger, were blown off the ground in at the

windows; and the very grass was blown quite flat on the ground. After the storm was over, he went out into the town, and such a miserable sight he never saw: the havoc above described, the women and children crying, the farmers all dejected. Two people, that were out in it all the time, said, that they heard it coming about half a minute before they saw it; and that it made a noise resembling thunder, more continued, and continually increasing. A man came from St. Ives, who says, the spire of the steeple, one of the finest in England, was blown down, as was the spire of Hemmingford, the towns having received as much damage as Bluntsham. There was neither thunder nor lightning with it, as there was at Cambridge, where it lasted above half an hour, and was not so violent.

Of a Fire-ball seen in the Air, on Dec. 11. 1741. *By Lord* BEAUCHAMP.

BEING then on the mount in Kensington Gardens, at a quarter past 10 o'clock, the sun shining bright, in a serene sky, Lord B. saw, towards the south, a ball of fire, of about eight inches diameter, and somewhat oval, which enlarged to the size of about a yard and a half diameter It seemed to descend from above, and at the distance of about half a mile from the earth took its course to the east, and seemed to drop over Westminster. In its course it assumed a tail of 80 yards in length; and before it disappeared, it divided into two heads. It left a train of smoke all the way as it went; and from the place where it seemed to drop there arose a smoke, which continued ascending for 20 minutes, and at length formed into a cloud, which assumed different colours.

Concerning the Fire-ball in the Air, Dec. 11. 1741. *By Mr.* CHRISTOPHER MASON.

ON that day, at Bucksteep, Sussex, about a quarter before one o'clock in the afternoon, Mr. M. observed a very dark uncommon appearance in the north, and at the same time the sun shone bright at his back; when, on a sudden, there was an explosion, as violent as the report of a mortar-piece, attended with a rumbling echo, which ran eastward; and he judges it came from about 40° elevation. Several people saw a ball of fire, which ran nearly eastward, leaving a train of light, which continued some time. The ball of fire was seen, and the report heard very loud, at Sompting, beyond Shoreham.

Of the Fire-ball seen Dec. 11. 1741. *By Mr.* Benj Cooke, *F. R. S. Dated Newport, in the Isle of Wight.*

A gentleman was on a hill about three miles west of that town, and had a very advantageous view of the fire-ball. He says, that the brightness of the sun was a little obscured by the interposition of some thin clouds, when he saw it pass by to the eastward, at about the distance of a quarter of a mile, and an apparent height of 30 feet above the level of the place where he stood. Its colour was that of a burning coal; its figure a cone, whose length might be eight feet, and diameter at the base 18 inches. From about its apex, which was its hinder part, issued several bright streams sparkling with fiery drops, to the length of about four or five feet. Its motion was nearly parallel to the plane of the horizon, and its direction about from south-west-by-south to north-east-by-north, without any noise, wind, or motion of the earth attending it.

Account of the Fire-ball seen Dec. 11. 1741. *By Capt.* William Gordon.

On Friday the 11th of December, 1741, about one P. M, coming by water from the city to Whitehall, and near to Hungerford Stairs, there appeared to Capt. G., between Vauxhall and Lambeth, a body of fire: it sprung upwards in its ascent almost perpendicular to the horizon, to the height of about 35°, in the space of a few seconds, and nearly in form of a large paper kite, projecting a long tail towards the north-west, not unlike those of slips of paper set on fire; in this state it continued so long, that he made the waterman lay his oars in, that he might the more easily observe whether it was the work of art or nature, as he was in some doubt. It had, from its first appearance, expanded itself considerably, so that the extreme breadth was seemingly equal to the diameter of a full moon arising from a dusky horizon. In this form it continued ascending for the space of two minutes, gently shooting to the north-east, till it arose to about 45°: then suddenly quitting its tail, which vanished, colouring the neighbouring clouds with a yellow on their separation, it formed itself first into a ball of fire; then shooting [illegible] to the south-east in a stream of light, disappeared, making a noise like a clap of thunder at some distance, and leaving behind it a smoky substance in its track.

Account of Margaret Cutting, a young Woman, at Wickham Market, in Suffolk, who speaks readily and intelligibly, though she has lost her Tongue. By HENRY BAKER, *F.R.S.*

Ipswich, April 9. 1742.—We have this day been at Wickham Market, to satisfy our curiosity concerning Margaret Cutting, a young woman, who, we were informed, could talk and discourse without a tongue.

She informed us, that she was now more than 20 years of age, born at Turnstal, a village within four miles of Wickham Market, in Suffolk, where she lost her tongue by a cancer, being then about four years old. It first appeared like a small black speck on the upper superficies of the tongue, and soon ate its way quite to its root. She was under the care of Mr. Scotchmore, a surgeon of Saxmundham, who soon pronounced the case incurable: however, he continued using the best means he could for her relief. One day when he was syringing it, the tongue dropped out, and they received it into a plate, the girl, to their amazement, saying to her mother, "Don't be frighted, mamma; it will grow again." It was near a quarter of a year after, before it was quite cured.

We proceeded to examine her mouth with the greatest exactness we could, but found not the least appearance of any remaining part of a tongue, nor was there any uvula. We observed a fleshy excrescence on the under left jaw, extending itself almost to the place where the uvula should be, about a finger broad: this excrescence, she said, did not begin to grow till some years after the cure: it is by no means movable, but quite fixed to the parts adjacent. The passage down the throat, at the place where the uvula should be, or a little to the right of it, was a circular open hole, large enough to admit a small nutmeg.

Notwithstanding the want of so necessary an organ as the tongue was generally supposed to be, to form a great part of our speech, and likewise to be assisting in deglutition, to our great admiration, she performed the office of deglutition, both in swallowing solids and fluids, as well as we could, and in the same manner: and as to speech, she discoursed as fluently and well as other persons do; though we observed a small sound, like what is usually called speaking through the nose; but she said she had then a great cold, and she believed that occasioned it. She pronounced letters and syllables very articulately; the vowels she pronounced perfectly, as also those

consonants, syllables, and words, that seemed necessarily to require the help of the tongue.

She read to us in a book very distinctly and plain; only we observed, that sometimes she pronounced words ending in *ath* as *et; end* as *emb; ad* as *eib;* but it required a nice and strict attention to observe even this difference of sound. She sings very prettily, and pronounced her words in singing as is common. What is still very wonderful, notwithstanding the loss of this useful organ the tongue, which is generally allowed by anatomists, and natural philosophers, to be the chief, if not the sole, organ of taste, she distinguishes all tastes very nicely, and can tell the least perceivable difference in either smell or taste.

We the underwritten do attest the above to be a true account.

Benjamin Boddington.
William Notcutt, Minister.
William Hammond, Apothecary.

The Effects of Cold at Prince of Wales's Fort, on Churchill River, in Hudson's Bay, North America. By Capt. Christopher Middleton, *F. R. S.*

Capt. M. observed, that the hares, rabbits, foxes, and partridges, in September, and the beginning of October, changed their native colour to a snowy white; and that for six months, in the severest part of the winter, he never saw any but what were all white, except some foxes of a different sort, which were grizzled, and some half red, half white.

That lakes and standing waters, which are not above 10 or 12 feet deep, are frozen to the ground in winter, and the fishes in them all perish. Yet in rivers near the sea, and lakes of a greater depth than 10 or 12 feet, fishes are caught all the winter, by cutting holes through the ice down to the water, and putting lines and hooks in them.

Beef, pork, mutton, and venison, that are killed at the beginning of the winter, are preserved by the frost, for six or seven months, entirely free from putrefaction, and prove tolerably good eating. Likewise geese, partridges, and other fowl, that are killed at the same time, and kept with their feathers on, and guts in, require no other preservative, but the frost, to make them good wholesome eating, as long as the winter continues. All kinds of fish are preserved in the like manner.

In large lakes and rivers, the ice is sometimes broken by

imprisoned vapours; and the rocks, trees, joists, and rafters of our buildings, are burst with a noise not less terrible than the firing of a great many guns together. The rocks which are split by the frost are heaved up in great heaps, leaving large cavities behind; which may be caused by imprisoned watery vapours, that require more room, when frozen, than they occupy in their fluid state. Neither is it wonderful that the frost should be able to tear up rocks and trees, and split the beams of our houses, when we consider its great force and elasticity. If beer or water be left in mugs, cans, bottles, or copper pots, though they were put by our bed-sides, in a severe night they are surely split to pieces before morning, not being able to withstand the expansive force of the inclosed ice.

Bottles of strong beer, brandy, strong brine, spirits of wine, set out in the open air for three or four hours, freeze to solid ice. He tried to get the sun's refraction to every degree above the horizon, with the quadrant, but to no purpose, for the spirits froze almost as soon as brought into open air.

The frost is never out of the ground; how deep cannot be certain. They have dug down 10 or 12 feet, and found the earth hard frozen in the two summer months; and what moisture is found five or six feet down is white like ice. The waters or rivers near the sea, where the current of the tide flows strong, do not freeze above nine or 10 feet deep.

All the water used for cooking, brewing, &c. is melted snow and ice; no spring is yet found free from freezing, though dug ever so deep down. All waters inland are frozen fast by the beginning of October, and continue so till the middle of May.

The walls of the house they lived in are of stone, two feet thick, the windows very small, with thick wooden shutters, which are close shut 18 hours every day in the winter. There are cellars under the house, where are put the wines, brandy, strong beer, butter, cheese, &c. Four large fires are made in great stoves, built on purpose, every day. As soon as the wood is burnt down to a coal, the tops of the chimneys are close stopped with an iron cover: this keeps the heat within the house, though at the same time the smoke makes their heads ache, and is very offensive and unwholesome; notwithstanding which, in four or five hours after the fire is out, the inside of the walls of the house and bed-places will be two or three inches thick with ice, which is every morning cut away with a hatchet. Three or four times a day they

make iron shot of 24 pounds weight red-hot, and hang them up in the windows of the apartments. Though a good fire be in the room the major part of the 24 hours, yet all this will not preserve the beer, wine, ink, &c. from freezing.

Coronæ and parhelia, commonly called halos and mock-suns, appear frequently about the sun and moon here. They are seen once or twice a week about the sun, and once or twice a month about the moon, for four or five months in the winter, several coronæ of different diameters appearing at the same time. Five or six parallel coronæ, concentric with the sun, are seen several times in the winter, being for the most part very bright, and always attended with parhelia or mock-suns. The parhelia are always accompanied with coronæ, if the weather be clear; and continue for several days together, from the sun's rising to his setting. These rings are of various colours, and about 40 or 50 degrees in diameter. The frequent appearance of these phenomena in this frozen clime seems to confirm Des Cartes's hypothesis, who supposes them to proceed from ice suspended in the air.

The aurora borealis is much oftener seen here than in England; seldom a night passes in the winter free from its appearance. It shines with a surprising brightness, darkening all the stars and planets, and covering the whole hemisphere: its tremulous motion from all parts, as well as its beauty and lustre, is much the same as in the northern parts of Scotland and Denmark, &c.

Concerning a Man who lived 18 *Years on Water. By Mr.* ROBERT CAMPBELL, *of Kernan*

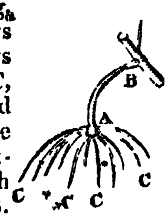
ABOUT 18 years since, viz. about 1724, John Ferguison, of the parish of Killmelfoord, in Argyleshire, happened to overheat himself on the mountains, in pursuit of cattle, and in that condition drank excessively of cold water from a rivulet, near by which he fell asleep; he awaked about 24 hours after in a high fever; during the paroxysm of the fever, and ever since that time, his stomach loathes, and can retain no kind of aliment, except water, or clarified whey; which last he uses but seldom, there being no such thing to be had by persons of his condition in that country during many months in the year.

Archibald Campbell of Ineverliver, to whom this man's father is tenant, carried him to his own house, and locked him up in a chamber for 20 days, and supplied him himself with fresh water, to no greater quantity in a day than an

ordinary man would use for common drink; and at the same time took particular care, that it should not be possible for his guest to supply himself with any other kind of food without his knowledge; yet after that space of time, he found no alteration in his vigour or visage.

He is now about 36 years of age; of middle stature; with a healthy, though not seemingly robust, complexion; his habit of body is meagre, but in no remarkable degree; his ordinary employment is looking after cattle; for which he must travel four or five miles a day in that mountainous country.

Observations and Experiments on the Fresh-water Polypus. By M. Trembley, at the Hague. Translated from the French, by P. H. Z., F. R. S.



The animal in question is an aquatic being. It is represented as sticking to a twig. Its body A B, which is pretty slender, has on its anterior extremity A, several horns, A C, which serve it instead of legs and arms, and which are yet slenderer than the body. The mouth of the polypus is in that anterior extremity; it opens into the stomach, which takes up the whole length of the body A B. This whole body forms but one pipe; a sort of gut, which can be opened at both ends.

The length of the body of a polypus varies according to its different species, and according to many other circumstances, to be mentioned hereafter.

M. Trembley knows two species, of which he has seen some individuals extend their bodies to the length of an inch and a half; but this is uncommon. Few are generally found above nine or 10 lines long; and even these are of the larger kind. The body of the polypus can contract itself, so as not to be above a line, or thereabouts, in length. Both in contracting and extending itself, it can stop at any degree imaginable, between that of the greatest extension, and of the greatest contraction.*

The length of the arms of the polypus differs also according to the several species: those of one of the species can be extended to the length of seven inches at least. The number of legs or arms is not always the same in the same species. We seldom see in a polypus, come to its full growth, fewer than six. The same may be said of the extension, and

of the contraction of the arms, as was said concerning the body. The body and the arms admit of inflexions in all their parts; and that in all manner of ways. From the different degrees of extension, contraction, and inflexion, which the body and the arms of the polypus admit of, result a great variety of figures, which they can form themselves into.

These animals do not swim; they crawl upon all the bodies they meet with in the water; or on the ground, on plants, on pieces of wood, &c. Their most common position is, to fix themselves by their posterior end B, to something, and so stretch their body and arms forwards into the water.

They make use of their progressive motion, to place themselves conveniently, so as to catch their prey. They are voracious animals: their arms extended into the water, are so many snares which they set for numbers of small insects that are swimming there. As soon as any of them touches one of the arms, it is caught. The polypus then conveys the prey to its mouth, by contracting or bending its arm. If the prey be strong enough to make resistance, he makes use of several arms. A polypus can master a worm twice or thrice as long as himself. He seizes it, he draws it to his mouth, and so swallows it whole. If the worm come endways to the mouth, he swallows it by that end; if not, he makes it enter double into his stomach, and the skin of the polypus gives way. The size of the stomach extends itself, so as to take in a much larger bulk than that of the polypus itself, before it swallowed the worm. The worm is forced to make several windings and folds in the stomach, but does not keep there long alive; the polypus sucks it, and after having drawn from it what serves for his nourishment, he voids the remainder by his mouth, and these are his excrements. According as the weather is more or less hot, the polypus eats more or less, oftener or otherwise.

They grow in proportion to what they eat; they can bear to be whole months without eating, but then they waste in proportion to their fasting.

The observations in the Philos Trans. principally concern the manner in which these polypi multiply. What is there said of them is true and exact. The more we search into the manner how a polypus comes from the body of its parent, the more we are persuaded that it is done by a true vegetation. There is not on the body of a polypus any distinguished place, by which they bring forth their young. M. T. had some of them, that greatly multiplied under his eyes,

and of which he can almost say, that they have produced young ones from all the exterior parts of their body.

A polypus does not always put forth a single young one at a time; it is a common thing to find those which produce five or six: he had some which put forth nine or 10 at the same time, and when one dropped off, another came in its place. These animals seem so many stems, from which issue many branches. He learned by a continual attention to two species of them, that all the individuals of these species produce young ones.

He next proceeds to the singularities resulting from the operations he tried upon them. If the body of a polypus be cut into two parts transversely, each of those parts becomes a complete polypus. On the very day of the operation, the first part, or anterior end of the polypus, that is, the head, the mouth, and the arms, lengthens itself, it creeps and eats.

The second part, which has no head, gets one: a mouth forms itself, at the anterior end, and shoots forth arms. This reproduction comes about more or less quickly according as the weather is more or less warm. In summer, he has seen arms begin to sprout out 24 hours after the operation, and the new head perfected in every respect in a few days. Each of those parts thus becomes a perfect polypus, performs absolutely all its functions. It creeps, it eats, it grows, and it multiplies; and all that, as much as a polypus which never had been cut.

In whatever place the body of a polypus is cut, whether in the middle, or more or less near the head, or the posterior part, the experiment has always the same success. If a polypus be cut transversely, at the same moment, into three or four parts, they all equally become so many complete ones.

The animal is too small to be cut at the same time into a great number of parts; he therefore did it successively. He first cut a polypus into four parts, and let them grow; next he cut those quarters again; and at this rate he proceeded, till he had made 50 out of one single one; and here he stopped, for there would have been no end of the experiment. He has several parts of the same polypus, cut into pieces about a year before; since which time they have produced a great number of young ones.

A polypus may also be cut in two lengthways. Beginning by the head, one first splits the head, and afterwards the stomach: the polypus being in the form of a pipe, each half of what is thus cut lengthways forms a half-pipe; the anterior extremity of which is terminated by the half of the head, the

half of the mouth, and part of the arms. It is not long before the two edges of those half-pipes close, after the operation. They generally begin at the posterior part, and close up by degrees to the anterior part. Then each half-pipe becomes a whole one, complete: a stomach is formed in which nothing is wanting, and out of each half-mouth a whole one is formed also.

He has seen all this done in less than an hour; and that the polypus, produced from each of those halves, at the end of that time did not differ from the whole ones, except that it had fewer arms; but in a few days more grew out. He has cut a polypus lengthways, between seven and eight in the morning, and between two and three in the afternoon each of the parts has been able to eat a worm as long as itself.

If a polypus be cut lengthways, beginning at the head, and the section be not carried quite through, the result is, a polypus with two bodies, two heads, and one tail. Some of those bodies and heads may again be cut lengthways, soon after. In this manner he has produced a polypus that had seven bodies, as many heads, and one tail. He afterwards at once cut off the seven heads of this new hydra: seven others grew again; and the heads that were cut off became each a complete polypus.

He cut a polypus transversely, into two parts: he put these two parts close to each other again, and they re-united where they had been cut. The polypus, thus re-united, ate the day after it had undergone this operation: it afterwards grew, and multiplied.

He took the posterior part of one polypus, and the anterior of another, and brought them to re-unite in the same manner as the foregoing: next day, the polypus that resulted, ate: it had continued well two months after the operation; grew, and put forth young ones, from each of the parts of which it was formed. The two foregoing experiments do not always succeed: it often happens that the two parts will not join again.

To comprehend the following experiment, we should recollect, that the whole body of a polypus forms only one pipe, a sort of gut, or pouch. He has been able to turn that pouch, that body of the polypus, inside outwards; as one may turn a stocking. He had several by him, that have remained turned in this manner: their inside is become their outside, and their outside their inside: they eat, they grow, and they multiply, as if they had never been turned.

Concerning the wonderful Increase of the Seeds of Plants, e.g. of the Upright Mallow. By Joseph Hobson *of Macclesfield.*

In the upright mallow, the seeds being disposed in rings, Mr. H. counted those which were on the principal stems, and found them as follows: —

Rings in all	- - -	10,199
Multiply by seeds in one ring	-	12 Seeds.
Number of seeds	- - -	122,388
Allow for two large stems destroyed		7612
Seeds in all	-	130,000

He then counted the seeds in several particular rings, and found them commonly 14 in each, but has confined himself to multiply the rings by 12, which is moderate, yet makes the number of seeds amount to 130,000, allowing 7612 seeds for two large stems cut down and destroyed; a moderate allowance, considering two of the stems alone contain each above 1000 rings: some of these stems were above two yards and a half high. This plant was a seedling last year, transplanted out of the fields on the end of a sloping strawberry-bed; and he counted the rings in the middle of July, when it had thousands of flowers upon it, which, with thousands that must still succeed, might very probably produce at least 50,000 seeds more, even supposing many of the flowers to produce no seed, considering 1000 rings contain 12,000 seeds and more: and if we multiply the number of rings actually counted by 14, the number of seeds contained in one ring, instead of 12, we shall have an addition of 20,000 seeds, all which, added together, amount to 200,000, the possible increase of one seed.

On the Method of Fluxions. By Colin Maclaurin.

The grounds of the method of fluxions are as follows: — Magnitudes are conceived to be generated by *motion*; and the *velocity* of the generating motion is the fluxion of the magnitude.

Lines are supposed to be generated by the motion of points. The velocity of the point that describes the line is its fluxion, and measures the rate of its increase or decrease.

Other magnitudes may be represented by lines that increase or decrease in the same proportion with them; and

their fluxions will be in the same proportion as the fluxions of those lines, or the velocities of the points that describe them.

When the motion of a POINT is uniform, its velocity is constant, and is measured by the space which is described by it in a given time. When the motion varies, the velocity at any term of the time is measured by the space which would be described in a given time, if the motion was to be continued uniformly from that term without any variation.

In order to determine that space, and consequently the velocity which is measured by it, four axioms are proposed concerning variable motions, two concerning motions that are accelerated, and two concerning such as are retarded.

The first is, that the space described by an accelerated motion is greater than the space which would have been described in the same time, if it had not been accelerated, but had continued uniform from the beginning of the time.

The second is, that the space which is described by an accelerated motion is less than the space which is described in an equal time by the motion which is acquired by that acceleration continued afterwards uniformly. By these, and two similar axioms concerning retarded motions, the theory of motion is rendered applicable to this doctrine with the greatest evidence, without supposing quantities infinitely little, or having recourse to prime or ultimate ratios.

The author first demonstrates from them all the general theorems concerning motion, that are of use in this doctrine; as, that when the spaces described by two variable motions are always equal, or in a given ratio, the velocities are always equal, or in the same given ratio; and conversely, when the velocities of two motions are always equal to each other, or in a given ratio, the spaces described by those motions in the same time are always equal, or in that given ratio; that when a space is always equal to the sum or difference of the spaces described by two other motions, the velocity of the first motion is always equal to the sum or difference of the velocities of the other motions; and conversely, that when a velocity is always equal to the sum or difference of two other velocities, the space described by the first motion is always equal to the sum or difference of the spaces described by these two other motions.

In comparing motions in this doctrine, it is convenient and usual to suppose one of them uniform; and it is here demonstrated, that if the relation of the quantities be always

determined by the same rule or equation, the ratio of the motions is determined in the same manner, when both are supposed variable. These propositions are demonstrated strictly by the same method which is adopted for determining the fluxions of figures.

A TRIANGLE that has two of its sides given in position, is supposed to be generated by an ordinate moving parallel to itself along the base. When the base increases uniformly, the triangle increases with an accelerated motion, because its successive increments are trapezia, that continually increase. Therefore, if the motion with which the triangle flows was continued uniformly from any term for a given time, a less space would be described by it than the increment of the triangle which is actually generated in that time by axiom 1., but a greater space than the increment which was actually generated in an equal time preceding that term, by axiom 2.; and hence it is demonstrated, that the fluxion of the triangle is accurately measured by the rectangle contained by the corresponding ordinate of the triangle, and the right line which measures the fluxion of the base. The increment which the triangle acquires in any time is resolved into two parts; that which is generated in consequence of the motion with which the triangle flows at the beginning of the time, and that which is generated in consequence of the acceleration of this motion for the same time. The latter is justly neglected in measuring that motion, or the fluxion of the triangle at that term, but may serve for measuring its acceleration, of the second fluxion of the triangle. The motion with which the triangle flows is similar to that of a body descending in free spaces by a uniform gravity, the velocity of which, at any term of the time, is not to be measured by the space described by the body in a given time, either before or after that term, because the motion continually increases, but by a mean between these spaces.

When the sides of a RECTANGLE increase or decrease with uniform motions, it may be always considered as the sum or difference of a triangle and trapezium; and its fluxion is derived from the last proposition. If the sides increase with uniform motions, the rectangle increases with an accelerated motion; and in measuring this motion at any term of the time, a part of the increment of the rectangle, that is here determined, is rejected, as generated in consequence of the acceleration of that motion.

The fluxions of a CURVILINEAL AREA (whether it be generated by an ordinate moving parallel to itself, or by a ray

revolving about a given centre,) and of the solid, generated by the area revolving about the base, are determined by demonstrations of the same kind; and when the ordinates of the figure increase, the increment of the area is resolved in like manner into two parts, one of which is only to be retained in measuring the fluxion of the area, the other being rejected as generated in consequence of the acceleration of the motion with which the figure flows. An illustration of the second and third fluxions is given by resolving the increment of a pyramid or cone into the several respective parts that are conceived to be generated in consequence of the first, second, and third fluxions of the solid, when the axis is supposed to flow uniformly.

Some further Account of Polypi, in a Letter from the Duke of RICHMOND, *F. R. S., to M.* FOLKES, *Esq. Pr. R. S. Dated Utrecht, May* 24. (*June* 4.) 1743.

You will not be sorry to receive some further account of the polypus; and I must tell you what I have seen in M. Trembley's study at Sorgvliet. He has there 12 large large glasses, of about a foot high, each holding from a gallon to six quarts of water, all well stocked with those animals, to the amount of many hundreds. They are, in general, considerably larger than any I had before seen; and as I was first with him on a Tuesday, and made him a second visit on the Sunday following, I had the opportunity of seeing the prodigious increase they had made in those five days. Several single ones that I had left, had in that time put out five or six young ones each; and those I had seen him perform operations on, were not only recovered, but had most of them produced young ones also.

I saw him split the head of one about two o'clock in the afternoon, and at about seven the same evening, each head ate a small worm. I saw him split another from the head to the tail, and each of those parts also ate part of a worm before night.

Another operation I saw him make, which I had not before heard of, which was that by putting one of the points of a very small pair of sharp scissors into the mouth of a polypus, and forcing it out at the very end of the tail, he then laid it quite open like a pigeon, or a barbacute pig to be broiled; yet, in about five hours, I saw the same polypus with the parts so re-united again, that I could not perceive any thing had been done to it; and it then ate a worm larger than itself.

He then showed me another odd particular, which was one polypus that had fairly two heads, without any tail; that is, with a head at each end. This was an accidental production, and as follows: two young ones grew, as from one root, out of an old polypus. They both dropped off together, and their tails not being separated, they appeared as just mentioned; but, when I saw them, with several young ones putting out from their sides.

M. Trembley said he had seen the like sometimes before, but not often; and that they have then remained 10 or 12 days in that condition, after which they have separated. He had in one of his large glasses upwards of a hundred of these insects all full grown, and he regaled them all at once before me, with some thousands of small aquatic animalcules, not unlike fleas, of about the size of large ones, and which move about with great swiftness in the water. These were no sooner put in, but it was a curious and entertaining sight, to observe in how voracious a manner not only every polypus, but every young one also that had arms, though fixed to the side of its parent, seized and devoured these pucerons; and as the body of the polypus is transparent, every one made a very extraordinary appearance, from the number of pucerons in them; for in several I could very plainly, with my bare eye, distinguish and count five or six of them; and I could plainly discern some very small black spots, which I was assured were the eyes of these pucerons.

One extraordinary observation more of M. Trembley's is, that, in the double-headed polypus, there was at first but one common gut between them, so that the feeding of one head had the same effect as feeding them both. M. Trembley is particularly handy and dexterous in his operations, and explains himself about them with great exactness and perspicuity. He places some pieces of packthread across his glasses, towards the top: to these some of the insects fix themselves; and I have seen some that in that position have extended their arms almost to the bottom, which must have been above 10 inches.

The Natural History of the Rhinoceros. By Dr. PARSONS.

When the rhinoceros arrived in England in 1739, Dr. Douglas went frequently to see it, for the purpose of correcting the opinions respecting it; and on June 24 of this year, exhibited before the Royal Society a drawing, with a collection of figures of that creature, taken from several authors, who

had written of him before. He mentioned also his dimensions; and on the 2&th of the same month, he produced a collection of horns, with some account of them, but proceeded no further." Therefore, as another occasion might not offer in many years, Dr. P. gives the following account of the male rhinoceros shown in Eagle Street, near Red Lion Square, in 1739, and the drawings annexed to it. In this account, he had no regard to those of other authors, but barely described him as he often saw him, both then and afterwards.

He was fed here with rice, sugar, and hay: of the first he ate seven pounds mixed with three of sugar every day, divided into three meals; and about a truss of hay in a week, besides greens of different kinds, which were often brought to him, and of which he seemed fonder than of his dry victuals; and drank large quantities of water at a time, being then, it seems, two years old.

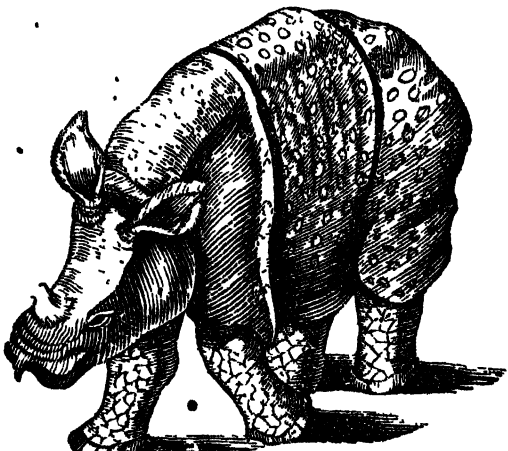
He appeared very peaceable in his temper, suffering himself to be handled in any part of his body; but outrageous when struck or hungry, and pacified in either case only by victuals. In his outrage he jumps about, and springs to an incredible height, driving his head against the walls of the place with great fury and quickness, notwithstanding his lumpish aspect: this Dr. P. saw several times, especially in a morning, before his rice and sugar were given to him.

In height he did not exceed a young heifer, but was very broad and thick. His head, in proportion, is very large, having the hinder part, next his ears, extremely high, in proportion to the rest of his face, which is flat, and sinks down suddenly forward towards the middle, rising again to the horn, but in a less degree. The horn stands on the nose of the animal, as on a hill. The part of the bone on which the horn is fixed rises into a blunt cone, to answer to a cavity in the basis of the horn, which is very hard and solid, having no manner of hollow nor core, like those of other quadrupeds.

That of this animal, being young, does not rise from its rough base above an inch high, is black and smooth at the top, like those of the ox-kind, but rugged downwards; the determination of its growth is backwards, instead of straight up; which is apparent, as well in the different horns of old rhinoceroses as in this of our present subject; for the distance from the base to the apex of this, backward, is not within a third part so long as that before, and it has a curved direction; and, considering the proportion of this animal's size to its horn, we may justly imagine, that the creature which bore any one of those great ones must have been a stupen-

dous animal in size and strength; and, indeed, it were no wonder, if such were untractable at any rate.

If we look at him in a fore view, the whole nose, from the top of the horn to the bottom of his lower lip, seems shaped like a bell, viz. small and narrow at top, with a broad base. His under lip is like that of an ox, but the upper more like that of a horse, using it, as that creature does, to gather the hay from the rack, or grass from the ground; with this difference, that the rhinoceros has a power of stretching it out above six inches, to a point, and doubling it round a stick, or one's finger, holding it fast; so that, as to that action, it is not unlike the proboscis of an elephant.



His neck is very short, being that part which lies between the back edge of the jaw and the plica of the shoulder; on this part there are two distinct folds, which go quite round it, only the fore one is broken underneath, and has a hollow flap hanging from it, so deep that it would contain a man's fist shut, the concave side being forward. From the middle of the hinder one of these folds or plicæ arises another, which, passing backwards along the neck, is lost before it reaches that which surrounds the fore part of the body. His shoulders are very thick and heavy, and have each another fold downward, that crosses the fore leg; and, almost meeting that of the fore part of the body just mentioned, they both double under the belly close behind the fore leg.

In some quadrupeds, the fetlock bends or yields to the

weight of the animal; but in this there is no appearance of any such bending, and he seems to stand on stumps, especially if he is viewed behind. He has three hoofs on each foot forwards; but the back part is a large mass of flesh, rough like the rest of his skin, and bears on the sole or bottom of his foot. This part is plump and callous in the surface, yielding to pressure from the softness of the subjacent flesh. Its shape is like that of a heart, having a blunt apex before, and running backward in a broad basis. The outline of the bottoms of the hoofs is somewhat semicircular.

The tail of this animal is very inconsiderable, in proportion to his bulk, not exceeding 17 or 18 inches in length, and not very thick; it has a great roughness round it, and a kind of twist or stricture towards the extremity, ending in a fatness, which gave occasion to authors to compare it to a spatula. On the sides of this flat part, a few hairs appear, which are black and strong, but short. There is no other hair on any part of this young rhinoceros, except a very small quantity on the posterior edge of the upper parts of the ears. There is a very particular quality in this creature, of listening to any noise or rumour in the streets; for though he were eating, sleeping, or under the greatest engagements nature imposes on him, he stops every thing suddenly, and lifts up his head, with great attention, till the noise is over. • • •

The skin of the rhinoceros is thick and impenetrable; in running one's fingers under one of the folds, and holding it with the thumb at the top, it feels like a piece of board ½ inch thick. Dr. Grew describes a piece of one of these skins tanned, which, he says, "is wonderfully hard, and of a thickness exceeding that of any other land animal he has seen." It is covered all over more or less with hard incrustations like so many scabs; which are but small on the ridge of the neck and back, but grow larger by degrees downwards toward the belly, and are largest on the shoulders and buttocks, and continue pretty large on the legs all along down; but, between the folds, the skin is as smooth and soft as silk, and easily penetrated; of a pale flesh-colour. which does not appear to view in the folds, except when the rhinoceros extends them, but is always in view under the fore and hinder parts of the belly, but the middle is incrusted over like the rest of the skin. To call these scabbed roughnesses scales, as some have done, is to raise an idea in us of something regular; which, in many authors, is a great inaccuracy, and leads the reader into errors; for there is nothing formal in any of them.

An Essay on the Causes of the different Colours of People in different Climates. By JOHN MITCHELL, *M. D.*

THE Colour of white People proceeds from the Colour which the Epidermis transmits; that is, from the Colour of the Parts under the Epidermis, rather than from any Colour of its own.— The truth of this proposition will plainly appear to those who consider, that the colour of white people is always more or less clear or vivid, as the skin is thinner or thicker, finer or coarser; that is, as it is more or less adapted to transmit the colour of the white parts below it. But this will be better confirmed from the following considerations: 1. The palms of the hands, lips, &c. where the epidermis and skin are so thin as to transmit the colour from any thing below them, appear red, or of the colour of the red blood under them; especially in those in whom the skin is fine and thin; but where the skin is thick and coarse, those parts appear almost of the same colour with the rest of the body. 2. The blushings of the cheeks, and their redness in fevers, seem to be another proof of this cause of their colour; for, in a moment, they change from a pale to a deep red; but no one will imagine, that the epidermis then changes its colour, or power of reflecting the rays of light; but that it transmits the colour of the blood; which at such times is more forcibly driven into the capillary subcutaneous vessels, and shines through the epidermis; but before, these vessels contained only a serous liquor, and accordingly the skin appeared of that colour: which will further appear on squeezing such red parts, which drives the blood out of them, and makes them appear white; whereas, on removing such pressure, they recover their colour, as the blood does its place. 3. The yellow colour of the skin in the jaundice is a further proof of this assertion; where the yellow bile is diffused through the vessels of the cutis, and appears through the epidermis; but no one will imagine, that the epidermis itself receives this viscid bile into its vessels; which are so small that many accurate anatomists, as Morgagni, have denied it to have any vessels at all; and the most accurate could never show them. 4. The pale look of those in whom the blood is viscid, or circulates with little force, shows that the epidermis then transmits the colour of the juices and fibres below it, which are then unmixed with red blood. 5. The same is manifest in those whose blood is poor and serous, as the leucophlegmatic, in whom the epidermis transmits the colour of the watery serum under it.

Hence it appears, that the epidermis is a transparent membrane, which easily shows the colour of the parts under it, in the same manner as the cornea of the eye transmits the colour of the iris.

The Skins of Negroes are of a thicker Substance, and denser Texture, than those of white People, and transmit no Colour through them.—For the truth of the first part of this proposition, we need only appeal to our senses, and examine the skins of negroes when separated from the body; when not only the cutis, but even the epidermis, will appear to be much thicker and tougher than in white people. But because the substance and texture, especially of the epidermis, is not a litle altered in anatomical preparations, and that in such a measure as to alter the texture, perhaps, on which the colour depends, by boiling, soaking, peeling, &c. let us examine the skins of negroes on their body; where they will appear, from the following considerations, to have all the properties assigned: 1. In bleeding, or otherwise cutting their skins, they feel more tough and thick, than in white people. 2. When the epidermis is separated by cantharides, or fire, it is much tougher and thicker, and more difficult to raise in black than white people. 3. Negroes are never subject to be sun-burnt, or have their skins blistered by any such degree of heat, as whites are. 4. Though their skins, in some particular subjects, should not be so very thick in substance, yet in winter, when they are dry, and not covered with that greasy sweat which transudes through them in summer, their skins feel more coarse, hard, and rigid; as they do in ardent fevers, with a dry skin. 5. Their exemption from some cutaneous diseases, as the itch, prickly heat or essere, which no adult negroes are troubled with, but those of fine and thin skins are most subject to, show the thickness or callosity of their skins, which are not easily affected from slight causes. 6. And not only the thickness, but also the opacity of their skins, will appear, from their never looking red in blushing, or ardent fevers with internal inflammations, nor in the measles, nor small-pox; where, though the blood must be forcibly impelled into the subcutaneous vessels, yet it does not appear through the epidermis. The like may be said of their veins; which, though large and shallow, yet do not appear blue, till the skin is cut. 7. In the jaundice, anasarca, &c. the skin of negroes never shows the colour of the parts under it, though visible enough in the eyes: of which Dr. M. saw a more convincing proof in some negroes labouring under a bilious fever, in whom the

serum of the blood, when let, was of a deep bilious yellow; but no yellow colour appeared on the skin, though plain enough to be seen in the eyes.

Hence might be deduced one plain cause of the blackness of negroes: for if the colour of the skin depends on what it transmits, and the skins of negroes transmit no colour through them, they must needs appear black; according to the known doctrine of light and colours, that wherever there is a privation of light or colour, there of course ensues darkness or blackness. But as most solid bodies, which are not pellucid, do generally reflect some colour, which we know no black body does, we shall next enquire into the particular make of their skins, by which they are rendered incapable to reflect, as well as to transmit, the rays of light.

The Part of the Skin which appears black in Negroes is the Corpus Reticulare Cutis, and external Lamella of the Epidermis; and all other Parts are of the same Colour in them with those of white People, except the Fibres which pass between those two Parts.— For a proof of this proposition, we must examine the structure of the skins of negroes more narrowly, which may be done after blistering with cantharides, or after a scald or burn; when their skins appear in the following manner: the cuticle, which is separated, appears nearly of the same colour on the outside, as before such separation from the body; but on the inner side is almost as white as the same part in white people.

The cutis itself, which lies under this black membranous expansion, and to which it is closely connected, is of a white colour in negroes, somewhat like the skin of many brown-skinned white people; but when this black corpus reticulare is on it, after the epidermis is separated, they appear, when both connected together, of a brown copper-colour, somewhat like the colour of an Indian or Mulatto; some of the colour of the white skin below being transmitted through this thin black membrane: which seems to show in what manner the colour of these Indians and Mulattoes may be occasioned, by the colour of the white membranes under their cuticles appearing partly and imperfectly through them, as the white skin does through this corpus reticulare.

Hence the formation of the epidermis seems to be more easily shown, and more completely deduced, than from any preparation of it in white people. For the external lamella of it manifestly arises from the corpus reticulare, by the intervention of the black fibrillæ, which has been shown to per-

vade the inner lamellæ of the epidermis; and this corpus reticulare itself arises from the subcutaneous nerves, so nicely and accurately delineated by Eustachius.

The Colour of Negroes does not proceed from any black Humour, or fluid Parts contained in their Skins; for there is none such in any Part of their Bodies, more than in white People. — It has been the generally received opinion, that the cause of the colour of negroes is a juice or fluid of a black colour, which lies between the epidermis and cutis, in some aqueous vessels, which serve to lubricate those parts. But this opinion needs only to be well and more thoroughly considered, to be confuted. But if there was any such thing as a black humour in the skins of negroes, no doubt it might be drawn out by some means or other; but, though Dr. M. had macerated the skins of negroes, and particularly the epidermis, in warm water, which readily dissolves the juices of the body, yet he never could extract any black juices from them, by any such maceration, or even by a more powerful expression.

The Epidermis, especially its external Lamella, is divided into two Parts, by its Pores and Scales, two hundred Times less than the Particles of Bodies, on which their Colours depend — Sir Isaac Newton informs us, that the particles of bodies, on which their colours depend, are about 600 times less than those which can be discerned with the naked eye. But Leuwenhoek shows, that a portion of the epidermis, no larger than what can be discerned with the naked eye, is divided into 125,000 pores; which pores must divide such a portion of the skin as can be discerned with the naked eye, into 125,000 particles; therefore each of these parts of the skin, between its pores, must be about 200 times less than those particles, on which the colours of bodies depend.

From this account of the cause of the difference in colour among those people that are white, we may account for the cause of the colour of Indians, and other tawny people, who seem to differ from each other in colour, and from white people only in degree, as they have more or less of this tawny yellow proceeding from the imperfect transmission of a white in their colours: thus, if we proceed from the swarthiest white person to the palest Egyptian, from thence to the fairest Mustee, Mulatto, Moor, &c. to the darkest Indian, we may plainly see, that they differ from each other only as they have more or less of the orignal white in their colour; and as we have shown this tawny colour in white people to proceed from the thickness or density of their skins, obstructing the transmission of the rays of light; so it is very plain that the

same tawny colour, in these other tawny people, which seems to be of the same kind, but different in degree, must proceed from a like cause, that is, the thickness or density of their skins; and accordingly it will be found, that all such people have skins of a thickness or density proportional to the whiteness or darkness of their colours.

So that, from the whole, we may conclude, that the proximate cause of the colour of negroes is threefold, viz. the opacity of their skins, proceeding from the thickness and density of their texture, which obstructs the transmission of the rays of light, from the white and red parts below them; together with their greater refractive power, which absorbs those rays, and the smallness of the particles of their skins, which hinder them from reflecting any light.

Hence we may justly infer, 1. That there is not so great, unnatural, and unaccountable a difference between negroes and white people, on account of their colours, as to make it impossible for both ever to have been descended from the same stock, as some people, unskilled in the doctrine of light and colours, are very apt, too positively, to affirm and believe. 2. That the epidermis, besides its other uses, tends to preserve the uniformity of the colours of people throughout the world.

The Influence of the Sun, in hot Countries, and the Ways of Life of the Inhabitants in them, are the remote Causes of the Colour of Negroes, Indians, &c. And the Ways of Living, in use among most Nations of white People, make their Colours whiter than they were originally, or would be naturally.—As for what relates to the remote causes of the colours of negroes, it has been generally supposed, though not universally believed, that the power of the sun in hot countries is the principal, if not the only agent, in producing this effect. The skin, then, is deprived of its white colour, by the force and influence of the sun, these four ways: 1. By being rendered opaque, from a dissipation of its more aqueous and pellucid juices: the known effect of the sun's heat, and which will render all bodies opaque.

2. By a concretion of its vessels and glandules, from this dissipation of their aqueous contents, which renders the skin both thicker and denser, or more callous or rigid.

3. By a new accretion of many new membranes, which render it thick and opaque. For the sun-beams act as a vibrating force, or external friction, on the skin, which derives fresh supplies of juices to it; by which new membranes, or lamellæ, are formed, in the same manner as the epidermis is renewed when abraded, which is very soon and easily done.

4. By increasing those parts or principles, in the composition of the epidermis, which have the greatest refractive powers. As the terrestrial, and fixed saline; but especially the tenacious sulphureous, which refract and absorb light more strongly than any other substances; while the more transparent and pellucid principles, as the aqueous, spiritous, and volatile saline, are evaporated by the heat, which causes the other more fixed principles to be accumulated in greater quantities, and combined in larger collections; and these particles, being likewise more comminuted by the sun, will on that account be black, as happens to oil when well boiled.

Hence it will appear, that the power of the sun's heat in hot countries, and its more immediate application to the body, or the increase of its force, by the nature of the soil, or ways of life, is the remote cause of the blackness, and the different degrees of blackness, of the inhabitants of the torrid zone: whereas the luxurious customs, and the effeminate lives of the several nations of white people, in the northern climes, are the remote causes of their respective fair complexions.

Observations on several Species of Fresh-water Polypi. By M. Abraham Trembley, F. R. S.

We find, in divers places, on water-plants, and other bodies in the water, a whitish substance, that looks at first only like a sort of mould: we sometimes see plants, sticks of wood, snail-shells, and the like, that are entirely covered over with this substance. But if we take any of these, put them into a glass of clear water, and then examine with a magnifying glass what is upon them, we soon discover in the little bodies, which by their assemblage form this whitish substance, such motions as give sufficient reason to consider them as living animals; and this will appear yet more sensible, when they come to be observed with a microscope.

In one case where the polypi are simple, they are not above the 210th part of an inch in length, and are of a shape nearly resembling that of a bell: one of these is represented exceedingly magnified. The anterior part, *a c*, generally appears open, when it properly presents itself; the posterior part, *i b*, is fixed to a stem or pedicle, *b e*; and it is by the extremity, *e*, of this pedicle, that the polypus fastens itself to any other sort of body. The polypus of this sort generally appears to the microscope of a brownish colour, excepting at its smaller end *b*. where it is

transparent, as well as its pedicle *b e*. When the anterior part, *a c*, is open, we may perceive about its edges a very lively motion; and when the polypus presents itself in a certain manner, it discovers, on either side of these edges of its anterior part, somewhat very much resembling the wheels of a little mill, that move with great velocity. These polypi are able to contract themselves; and they do so often, and suddenly.

We should begin to observe a polypus soon after it has fixed itself singly, in order to see regularly in what manner the clusters form themselves, and in what way these small creatures multiply. The stem or pedicle of a polypus that is yet single, and which has but lately fixed itself, is at first very short, but lengthens itself in a little time. After that, the polypus multiplies; that is to say, it divides or splits itself into two, lengthwise. The lips are first drawn into the body, whose anterior part closes, and becomes round: the motion that was to be seen before the lips were drawn in no longer appears; yet we may see, by looking with attention, a slow motion within the body, during all the time that the polypus remains closed. The anterior part of the polypus becomes flattened afterwards by degrees, and spreads in proportion, becoming broader as it shortens; it then gradually splits down through the middle, that is, from the middle of the head to the place where the posterior end joins to the pedicle; so that, in a little while, there appear two separate round bodies joined to the extremity of the pedicle that just before supported but one.

The anterior part of each of these bodies then opens by degrees; and, as they open, the lips of the new polypi show themselves more and more. Then is the time of observing these lips with attention, and of forming an idea of their true form, and of their motion. This motion is at the first very slow, it quickens as the polypi continue to open; and, as soon as they have done, it becomes as swift as that which appeared in the lips of the whole single polypus, before it began to divide; and then these new polypi may be considered as entirely formed. They are at first less than the polypus from which they were formed; but they grow to the same size in a very little time. A polypus is about an hour in dividing itself.

The engraving represents a cluster of eight polypi; and by this figure it may be apprehended in what manner the pedicles of the polypi become disposed, as their numbers increase. These several pedicles become so many branches

of the cluster or sprig. This figure particularly represents a cluster, whose progress M. T. followed in the month of September, 1744. It consisted, on the 9th day of that month, of only one single polypus, which was placed as at *b*; this polypus divided itself that evening, and at half an hour after eight o'clock, there were to be discovered at *b* two perfect polypi, whose pedicles or branches, *b d*, *b d*, continued lengthening till the morning of the next day, being the 10th of the same month of September: at about a quarter after nine that morning, these two polypi, which were then at *d*, *d*, began also each to divide; so that at a quarter past 11, there were at *d* and *d* four complete polypi, whose several pedicles, *d i*, *d i*, *d i*, *d i*, formed themselves soon after. On the 11th of the same September, about half an hour after seven in the morning, these last four polypi had already again divided themselves; that is, that there were at *i*, *i*, *i*, *i*, eight distinct polypi; and this cluster, so consisting of eight polypi, is here represented as it appeared on the 12th of the same month, between 10 and 11 in the forenoon.

Mr. T. has seen four other species of polypi, that increase in the same manner as those above mentioned; that is, which split and divide themselves according to their length. Those which come the nearest to the first are somewhat more slender, and the branches of their clusters are transparent, and they appear, when there is a number of them together, of a changeable violet-colour: the clusters of these bear a good resemblance to a sprig or aigrette of spun glass.

Mr. T. also observed, regularly, other small polypi, of a different sort from those that are found in clusters. These are nearly in shape like a tunnel, pretty long in proportion to the opening of their larger ends. For this reason, Mr. De Reaumur has thought proper to distinguish them by the name of tunnel like polypi. He is acquainted with three species of these last polypi, which are, respectively, green, blue, and white. Their anterior end, particularly, is of a far more compounded shape than may at first be imagined. There may be observed round the edges of this part a sensible motion, much resembling that of an indented wheel, or rather of an endless screw, turned very fast about. These tunnel-like polypi form no clusters, like the others. The little bodies,

that pass floating near the anterior parts of these insects, are in some manner drawn into the mouths of their tunnels; and sometimes a considerable number of very small round animalcula fall one after another into these openings. Some of these were indeed afterwards let out again, at another opening; but it could plainly be seen, that many of these little round bodies remained within the bodies of the polypi; and it is therefore apparent that these little bodies, so taken in, became their food.

These tunnel-like polypi also multiply by dividing into two, but they divide otherwise than the clustering polypi; they neither divide longitudinally nor transversely, but sloping and diagonal-wise. Of two tunnel-like polypi, just produced by the division of one, the first has the old head and a new posterior end; and the other the old posterior end, with a new head.

On Fossil Shells. By the Rev. Roger Pickering.

At Woodbridge, in Suffolk, in a farmer's ground, there are some pits, in depth equal to the usual height of houses, consisting of several strata of shells, from the bottom to within about nine feet of the surface, where the natural soil of gravel and sand begins. The mass of shells here collected is prodigious; the sorts various: but the buccinum vulgare, or whilk, prevails the most. The depth to which these shells reach is not yet dug down to. Woodbridge is seated seven miles N. E. from Ipswich; and is about the same distance from Orford on the sea-coast, which bears from it due east. How such a mass of shells should get there at such a distance from the sea, when history has not informed us of any remarkable inundation in those parts, or that such a tract of land was ever recovered from the sea, appears difficult to determine. Indeed the river Deben, which rises at Debenham, some miles off, runs by Woodbridge, within half a mile of these pits, in its course to the German Ocean, where it empties itself: but such a collection of shells can hardly be supposed to have been thrown up by it, and a surface of earth to the depth of nine feet, settled over it, without allowing a space of time for such a circumstance almost equal to the interval between us and the deluge.

Concerning an extraordinary large Fossil Tooth of an Elephant. By Mr. Henry Baker, *F.R.S*

The fossil tooth Mr. B. received from Norwich. It seems to be a grinder belonging to the left under jaw of a very

large elephant, as its own size and weight may show: for the circumference, measured by a string drawn round the edge, is three feet, wanting one inch; in length it measures 15 inches; in breadth, where widest, seven inches; in thickness, about three, and its weight is upwards of 11 pounds.

On one side it is convex, and on the other concave, with 16 ridges and furrows running on each side transversely, and corresponding with the same number of eminences on the grinding edge, which appears furrowed like a millstone. On the bottom of the part that lay within the gum are several cavities for the insertion of the nerves. The whole tooth is almost entire, and seems very little, if at all, petrified; but, since its being exposed to the air, several little cracks appear. Other monstrous bones were found with it; and particularly thigh-bones, six feet long, and as thick as the thigh of a man; all which belonged, probably, to the same animal, and may be considered as farther proofs of the creature's enormous size.

The place where, and the manner how, these bones were discovered, are curious particulars. A little town, called Munsley, is situated close to the sea-shore, on the north-east coast of the county of Norfolk, where the sea is bounded by exceedingly high rocky cliffs: some of these being gradually undermined by the continual dashing of the waves when the tide comes in, great pieces frequently tumble down on the shore, and by the tumbling down of one of these the above-mentioned bones and grinder were discovered.

This discovery seems a convincing demonstration, that the earth has undergone some very extraordinary alterations: for the remains of animals, of quite different climates and regions, and of kinds which, in the present situation of the world, could never possibly come over hither, must either imply their having been placed here by Providence originally, or that this island must heretofore have been contiguous to the Continent: but since we find these creatures in very hot countries only, it is highly probable they were never placed here by Providence.

What changes have happened to our earth, and how they ave been produced, no human wisdom can possibly find out with any certainty. But suppose only the polar points, or the axis, to have been shifted at any time but a few degrees, and its centre of gravity to have been altered, which some great men have imagined not improbable, what convulsions in nature, what a universal change in the face of things, must thus have been occasioned! what inundations, or deluges of

water, bearing every thing before them! what breaches in the earth, what hurricanes and tempests, must have attended such an event! for the waters must have been rolled along, till, by them, an equipoise was produced.

All this, indeed, is barely conjecture: but the bones and teeth of fishes, the multitudes of sea-shells, some of which are petrified, and others not, and the many sea-productions found buried in the earth in almost every country, at vast distances from the sea, and even in the midland parts, are demonstrations of the surprising alterations that must have happened as to the disposition of sea and land.

The thigh-bones of six feet long exceed, also, by two feet, any ever yet heard of; and, according to Mr. Blair's osteology of an elephant nine feet high, which died at Dundee in Scotland, in the year 1706, and whose thigh-bones were three feet in length, we may suppose, by the rules of proportion, that the elephant, to which our bones and tooth belonged, was 18 feet in height.

An Account, in Pounds and Ounces, of the surprising Quantities of Food devoured by a Boy, 12 Years old, in six successive Days, at Black Barnsley, in Yorkshire Communicated by Dr. Mortimer, Sec. R.S.

The boy was regular as other children, till about a year before the above date, when this extraordinary craving of appetite first began; which afflicted him to such a degree, that if he was not fed as he called out for it, he would gnaw the very flesh off his own bones; so that, when awake, he was constantly devouring; it could hardly be called eating, because nothing passed his stomach; all was thrown up again.

Of the various substances, bread, meat, beer, milk, water, butter, cheese, sugar, treacle, pudding, rye, fruit, broth, potatoes, &c. he swallowed in the six successive days, as follows; viz.

Thursday	-	69 lb	8 oz.
Friday	-	61	14
Saturday	-	58	8
Sunday	-	77	0
Monday	-	60	12
Tuesday	-	55	8
Salt	-	1	0 in the six days
Total	-	384	2

On the Death of the Countess Cornelia Zangári and Bandi, of Ceséna.

The Countess Cornelia Bandi, in the 62d year of her age, was all day as well as she used to be, but at night was observed, when at supper, dull and heavy. She retired, was put to bed, where she passed three hours and more in familiar discourses with her maid, and in some prayers: at last, falling asleep, the door was shut. In the morning, the maid taking notice that her mistress did not awake at the usual hour, went into the bed-chamber and called her; but not being answered, doubting of some ill accident, opened the window, and saw the corpse of her mistress in the deplorable condition following:—

Four feet distance from the bed there was a heap of ashes, two legs untouched, from the foot to the knee, with their stockings on: between them was the lady's head: whose brains, half of the back part of the skull, and the whole chin, were burnt to ashes; among which were found three fingers blackened. All the rest was ashes, which had this particular quality, that they left in the hand, when taken up, a greasy and stinking moisture.

The air in the room was also observed cumbered with soot floating in it; a small oil-lamp on the floor was covered with ashes, but no oil in it. Two candles in candlesticks on a table stood upright; the cotton was left in both, but the tallow was gone and vanished. Somewhat of moisture was about the feet of the candlesticks. The bed received no damage; the blankets and sheets were only raised on one side, as when a person rises up from it, or goes in: the whole furniture, as well as the bed, was spread over with moist and ash-coloured soot, which had penetrated into the chest of drawers, even to foul the linens; nay, the soot was also gone into a neighbouring kitchen, and hung on the walls, moveables, and utensils of it.

It was remarkable, that the floor of the chamber was so thickly smeared with a gluish moisture, that it could not be taken off; and the stench spread more and more through the other chambers.

In the Acta Medica et Philosophica Hafniensia, published by Thomas Bartholin, 1673, a similar accident is related in these words:—"A poor woman at Paris used to drink spirit of wine plentifully for the space of three years, so as to take nothing else. Her body contracted such a combustible disposition, that one night she, lying down on a

straw couch, was all burned to ashes and smoke, except the skull and the extremities of her fingers."

John Henry Cohausen relates, "That a Polish gentleman, in the time of the Queen Bona Sforza, having drank two dishes of a liquor called brandy-wine, vomited flames, and was burnt by them."

The narrator's opinion is, that the fire was caused in the entrails of the body by inflamed effluvia of her blood, by juices and fermentations in the stomach, by the many combustible matters which are abundant in living bodies for the uses of life; and, finally, by the fiery evaporations which exhale from the settlings of spirit of wine, brandies, and other hot liquors, in the tunica villosa of the stomach, and other adipose or fat membranes, within which, as chemists observe, those spirits engender a kind of camphor; which, in the night-time, in sleep, by a full breathing and respiration, are put in a stronger motion, and, consequently, more apt to be set on fire.

Some Observations on the Cancer Major. By Mr. Peter Collinson

The cancer major, or largest species of crabs, have their chief abode in water from 20 to 40 fathoms in depth: they herd together in distinct tribes, and have their separate haunts for feeding and breeding, and will not associate with their neighbours. This has been carefully tried, by taking a crab, and marking its shell, and carrying it two or three miles distance, and leaving it among the same species: this crab has found its way back to its old home, and has been caught by the same fishermen that carried it.

The smallest crab that comes to hand is about the size of a chestnut; the full grown 7 lb. weight; but there has been one caught that weighed 12 lb. The bait is flesh, or pieces of skait, or small shark, of which he eats but little. The fishermen all agree, the crab will live confined in the pot or basket some months, without any food but what is collected from the sea-water, and not decrease in weight.

Once a year, like the lobster, they lose or cast their shells. Against this extraordinary change, they choose a close and well-secured retreat in the cavities of rocks, and under great stones; there they creep in, and wait, till by degrees the parts are disengaged; which is effected by withdrawing their legs from their old shells, leaving them, and the upper part of their body-shell behind. In this naked state they make a very odd appearance, being an ill shapen lump of jelly-like substance

which gradually hardens into a shell a size larger than the old one: for this is the way of growth appointed for this animal, and others of the crustaceous species. But what is most surprising, this large species of crab has a power in itself voluntarily to crack and break its own legs or claws, and drop them off.

Mr. Benjamin Cook, at Newport, in the Isle of Wight, F.R.S., informed Mr. C. of this marvellous property in the great crab; but he could not comprehend it, till he saw the experiment tried on two crabs; then he was soon convinced of the truth of the fact; for in a few minutes the legs all dropped off one after another. This the crab will do in any position; but the easiest method is to lay it on its back, and then take a pair of strong iron pincers, and break the shell, and bruise the flesh, of the third or fourth joint of its small leg; after it has received the hurt, it bleeds, and gives signs of pain, by moving its leg from side to side; but afterwards holds it quite still, in a direct and natural position, without touching any part of its body, or its other legs, with it. Then, on a sudden, with a gentle crack, the wounded part of the leg drops off at the second joint, or internodium, from its body; just as one sees the neck of a retort separate, where it has been heated by a red hot iron ring, on the application of cold water. The great legs are cast off in the same manner, but are not so easily laid hold on as the small ones. Those who have not seen this wonderful operation may reasonably conclude, that the leg is cast out of its joint or socket; but it is quite otherwise; for it cracks and breaks off in the smoothest part of the joint, and the rim of the body-shell is no way assistant to it.

To try what effect increase of pain would have in this work, a small hole was pierced in the great legs, and then a pointed iron was put in to lacerate the inclosed muscle; the consequence was answerable to expectation; symptoms of greater pain ensued, and the leg was cast off with greater violence.

It is really amazing and inconceivable, by what power or contrivance in itself, so wonderful an operation can be performed by the crab, as voluntarily to crack and break so hard a shell, and its muscles, and then cast off its legs. The small diameter of this joint, the disposition of the fibres, and a very small circular fossa, may contribute greatly to accelerate the work; but yet the main spring of action seems beyond the reach of human comprehension.

When the leg is dropped off, a mucus or jelly is discharged

on the remaining part of the joint next the body, which, as a natural styptic, instantly stops the bleeding, and gradually hardens and grows callous, and forms into a leg in miniature, which by degrees shoots forth, and attains to its natural size, to supply the place of that which was lost.

The crabs are naturally very quarrelsome, and with their great legs or claws fight and kill each other: with them they catch hold of their adversary's legs, and whatever they seize, they strongly retain for a long while: there is no escaping their cruel foe, but by voluntarily leaving a part of the leg behind, in token of victory; but the principal end for which this is done, is the saving the life of the conquered: for when they are bitten and bruised, and cannot break off that limb, they soon bleed to death.

The fishermen showed an experiment, to give some idea of the tenacious disposition of this creature, by obliging a crab with its great claw to lay hold of a small one; the silly creature did not distinguish that itself was the aggressor; but exerted its strength, and soon cracked the shell of its own small leg, and it bled freely; but feeling itself wounded, to save its life required a power peculiar to itself to break off that limb in the usual place, which it presently effected, and held fast for a long time the broken part in his great claw: which evidently shows, that this creature retains whatever it lays hold on, and when overcome by its enemy, ransoms its life at the expense of a limb.

Observations on the Precipices or Cliffs on the North-east Sea Coast of the County of Norfolk. By Mr. WILLIAM ARDERON.

THE various strata, which make up this long chain of mountainous cliffs, must be very interesting to every one, who takes a pleasure in looking into the many changes which the earth undoubtedly has undergone, since its first creation. Vegetable mould, sands of various kinds and colours, clays, loams, flints, marls, chalk, pebbles, &c., are here to be seen at one view beautifully interspersed; and frequently the same kind many times repeated; as if at one time dry land had been the surface; then the sea; after, morassy ground; then the sea, and so on, till these cliffs were raised to the height they are now found.

This is demonstrated by the roots and trunks of trees, which are to be seen at low water in several places on this coast,

near Hasborough and Walket: bones of animals are often found here also.

These hills seem to have been formerly the boundaries to an arm of the sea, which made Norwich a famous sea-port. This some of our ancient histories make mention of as an undoubted truth, though now considered as a mere fable, as no vestiges of it remain above ground at this day.

In the above-mentioned marl pits he discovered a stratum of shells, of about two feet thick, running nearly parallel to the horizon. He examined carefully this stratum, where he found a great many kinds of shells; but none which had withstood time's all-devouring teeth, so as to bear the handling; excepting the common wilk, some of which were very perfect. Among the variety of things he noticed in this stratum was a piece of coal, which he picked out from among the shells. This must have lain here as long as they, and been brought from some other county, as nothing of its kind is to be found here, but what is brought from distant parts. These shells lie 14 yards above the surface of the river, and nearly six beneath the top of the hill, and he believes 51 yards above the surface of the sea at Yarmouth. And it is very remarkable, that in these marl pits, six or seven yards lower than the above-mentioned stratum of shells, are found a vast quantity of stags' horns lying in all directions. Several I took out with my own hands; and the workmen, who are employed here, say, that they scarcely work a day, but they find more or less of them. But none are found entire.

These horns have been very large ones; some of the spines measuring 12 inches and upwards in length. Many of them are more than 2½ inches in diameter, and several of them above 12 inches from spine to spine.

Another curiosity was the entire skeleton of a man, which was found in the same stratum with the above-mentioned horns, as one of the workmen assured me: he said, he took the pains to lay it altogether on the grass, as regularly as he was able, but his curiosity being then satisfied, he left it to be ground to pieces by the carts and waggons that came thither for the marl.

Among the clay lie a great many knots, lumps, or nodules, of a bluer kind of earth, not widely differing from that which is found in Harwich cliff: these, when digged up, are soft: but when they have been for some time exposed to the open air, they become almost as hard as flint. In and upon these lumps are the impressions of the cornu ammonis, or snake-stones, in a beautiful manner, from one inch to five or six in

diameter, and several have part of the shells on them, of a yellowish white. Many other shells are found in these lumps; as the pectunculus, helmet stones, belemnites, common cockle, turbos, &c.; but these are most of them very small.

Observations on a sort of Libella, or Ephemeron. By Mr. PETER COLLINSON.

WALKING by the river's side at Winchester, Mr. C. was told, that now was the time of year that the May-flies, a species of libella, came up out of the waters, and were seen for a few days, and then disappeared.

May 26. 1744, he was first shown it by the name of May-fly, on account of its annual appearance in that month. It lies all the year, except a few days, in the bottom or sides of the river: and nearly resembles the nymph of the small common libellas; but when it is mature, it rises up to the surface of the water, and splits open its case; then, with great agility, up springs the new animal, with a slender body, with four blackish-veined transparent shining wings, having four black spots in the upper wings, the under wings being much smaller than the upper ones: it has three long hairs in its tail.

The next business, after this animal is disengaged from the water, is flying about to find a proper place to fix on, as trees, bushes, &c. to wait for its approaching change, which is effected in two or three days. The first hint he received of this wonderful operation, was seeing their exuviæ hanging on a hedge. He then collected a great many, and put them in boxes; and by strictly observing them, he could tell when they were ready to put off their old clothes, though but so lately put on.

He had the pleasure to show his friends one that he held on his finger all the while it performed this great work: it was surprising to see how easily the back part of the fly split open, and produced the new birth, which he could not perceive to partake of any thing from its parent; but leaves head, body, wings, legs, and even its three-haired tail behind, or the cases of them. After it has reposed itself awhile, it flies with great briskness to seek its mate.

By much the greater numbers perish on the waters, which are covered with them. This is the end of the females; but the males never resort to the river that he could perceive: after they have done their office, they drop down, languish, and die, under the trees and bushes.

He observed that this species of libella abounded most with females; which was very necessary, considering the many enemies they have during their short appearance; for both birds and fish are very fond of them, and doubtless under the water they are a food for small aquatic animals.

What is further remarkable in this surprising creature is, that in a life of three or four days it eats nothing, seems to have no apparatus for that purpose, but brings up with it out of the water sufficient support to enable it to shed its skin, and perform the principal ends of life with great vivacity.

On the Perpendicular Ascent of Eels. By Mr. Wm. Arderon, F.R.S.

On reading, some years before, what Dr. Plot, in his History of Staffordshire, relates concerning the passage of eels across meadows, in the night-time, from pond to pond, Mr. A. could hardly forbear thinking that the gentleman must have been deceived; but what Mr. A. has lately seen gives him great reason to believe that account to be strictly true.

On June 12. 1745, while viewing the flood-gates belonging to the water-works in the city of Norwich, he beheld a great number of eels sliding up them and the posts adjacent, notwithstanding they all stood perpendicular to the horizon, and five or six feet above the surface of the pool below the water-works. They ascended these posts and gates, till they came into the dam above. And, what makes the matter appear still more strange, they slid up with the utmost facility and readiness; though many of the boards and posts were quite dry, and as smooth as a common plane had left them.

He observed, that at first they thrust their heads, and about half their bodies, out of the water, and held them up against the wood-work for some time: probably till they found the glutinous matter, which is constantly about their bodies, become sufficiently thick or viscid, by being exposed to the air, to sustain their weight: then they would begin to ascend directly upwards, with as much seeming ease, as if they had been sliding along the level ground; and thus they continued to do, till they got into the dam above.

On Birds of Passage. By Mr. Mark Catesby, F.R.S.

The places to which birds of passage retreat when they leave us, are first of all to be enquired after, and then it will be proper to examine by what route, and in what manner,

they convey themselves to such places. The reports of their lying torpid in caverns and hollow trees, and of their resting in the same state at the bottom of deep waters, are so ill attested, and absurd in themselves, that the bare mention of them is more than they deserve.

The various conjectures concerning the places to which birds of passage retire, are occasioned by the want of ocular testimony to bring the matter to some certainty. But if the immenseness of the globe be considered, and the vast tracts of land which still remain unknown to us, it is no wonder that we are yet unacquainted with the retreat of these itinerant birds. On this head Mr. C. agrees in the general opinion of their passing to other countries by the common natural way of flying, with this additional conjecture, that the places to which they retire, lie probably in the same latitude in the southern hemisphere, as the places from whence they depart; where the seasons reverting, they may enjoy the like temperature of air.

It may be objected, that places of the same latitude in the southern hemisphere may be divided by too wide a tract of sea for them to pass over. But why then may not some other parts of the southern hemisphere serve their turn? This seems more reasonable, than that they should remain on our side of the northern tropic; within a few degrees of which, at the winter solstice, it is so cold, as frequently to produce snow; which, by dispersing such insects as birds that feed on the wing, and particularly the swallow kinds, subsist on, must make them perish inevitably, were they not to change their quarters for those more favourable climes, where a continuance of warm weather affords their natural and proper food. This their sagacity dictates to them, and is the apparent cause of their periodically leaving us at the approach of winter, before flies are so dissipated by cold and winds as to be found no longer in the air, though they may with other insects be met with in holes and hidden recesses, and serve to subsist other birds of passage.

What Mr. C. infers from hence is, that as swallows cannot continue and subsist so long in cold seasons as other birds of passage, they are necessitated to visit us somewhat later, and to depart sooner; for though nightingales, and other birds of passage, are not often seen or observed after they cease singing, yet he has frequently noticed them in their solitary coverts a month after the departure of swallows. From these reasons he concludes, that birds of passage, particularly swallows, are necessitated to pass the tropic of Cancer; but

how far more south, or to what part of the southern hemisphere they go, remains unknown.

The manner of their journeying to their southern abode may vary, as the different structure of their bodies enables them to support themselves in the air: those birds with short wings, such as the red-start, blackcap, &c., though they are incapable of such long flights, and with so much celerity, yet he thinks they may pass in like manner, but by gradual and slower movements. Swallows and cuckows may probably perform their flight in half the time; yet there seems no necessity for a precipitate passage, because every day's passage affords them increase of warmth, and a continuance of food a longer time than is necessary for their passage, were it to the same latitude south as that from whence they go.

Why may not these, and other itinerant birds, perform their long journeys in the night-time, to conceal themselves from rapacious birds, and other dangers that day-light exposes them to? which nocturnal travelling of birds of passage he believes more than barely probable, from the following observations, which may serve in some degree to confirm it. Lying on the deck of a sloop on the north side of Cuba, Mr. C. and the company with him heard, three nights successively, flights of rice-birds, their notes being plainly distinguishable from others, passing over their heads northerly, which is their direct way from Cuba, and the southern continent of America, whence they go to Carolina annually at the time that rice begins to ripen; and, after growing fat with it, return south back again.

There are also winter birds of passage, which arrive here in autumn, at the time the summer birds depart, and go away in the spring season, when summer birds return. These, however, are but few, there being only four sorts known, viz. the fieldfare, redwing, woodcock, and snipe; which last two he has often known to continue the summer here, and breed; so that the fieldfare and redwing seem to be the only birds of passage that constantly and unanimously leave us at the approach of summer, retiring to more northern parts of the Continent, where they breed, and remain the summer, and at the return of winter are driven southerly from those frigid climates in search of food, which there the ice and snow deprive them of. When the severity of our winters deprives them of their liquid sustenance, necessity obliges them to retire towards the sea in numerous flights, where in open brackish waters they find relief, and at the approach of the spring they retire to their summer recesses. But these

cannot be included among those usually termed birds of passage.

Besides the different kinds of swallows, there is but one kind of European bird that subsists in like manner by catching its food on the wing, that is, the caprimulgus, or goatsucker, the capacious structure of whose mouth and gullet is formed to receive insects of the larger kinds, as scarabæi, grillotalpæ, &c. These are also birds of passage.

We have made it pretty evident, that summer birds of passage come to, and depart from, us, at certain seasons of the year, merely for the sake of a more agreeable degree of warmth, and a greater plenty of food; both which advantages they procure by an alternate change of climate; but the migration of winter birds of passage, and particularly of fieldfares and redwings, is much more difficult to be accounted for; there being no such apparent necessity, either on the score of food or climate, for their departure from us.

The reason of their coming here in winter is probably for the sake of food, and a more suitable climate than that they leave: but in some severe cold seasons, and when there is a scarcity of berries, they subsist here with difficulty, and are even famished sometimes for want of sufficient food; yet what appears most unaccountable is, that such as have continued with us a whole winter in penury, and should, one would imagine, rejoice at our approaching spring, and build their nests, and couple, on the contrary all depart, as if that mild and pleasant temperature, which delights and cherishes most other creatures, were disagreeable to them. We know the places of their summer retirement to be Sweden, and some other countries in that latitude; but, as they would find those countries too cold for their reception, and probably destitute of provision, were they to hasten directly thither when they depart from hence, they journey gradually, and prolong their passage through the more moderate countries of Germany and Poland, by which means they arrive not at those northern regions, adapted by Providence for their summer abode, and the breeding of their young, till the severity of the cold is so much abated as to render it pleasing to them, and food may be there found. When they visit us again in winter, their return back is after the same manner.

The winter food of these birds being berries, and particularly haws, as a greater abundance of them grow in this island than can be supposed in the more northern regions, that may possibly be one great allurement to bring them over hither; but the principal reason inducing them to travel

southward, is probably the rigour and severity of the cold in those frigid climes, which nature therefore directs them to desert for such as are more temperate.

Concerning the Property of Water Efts, in slipping off their Skins as Serpents do. By Mr. DAVID ERSKINE BAKER.

THIS animal is to be found in the spring, and during the whole summer season, in most ditches and shallow standing waters throughout England, being unknown to very few. It has long been known, that most of the serpent kind put off, or, as we commonly term it, cast their skins, at certain periodical times; though we are very little acquainted with the manner of their performing this work, since it is commonly done in their retiring places, where we can seldom get a sight of them; nor should we indeed know that their skins were changed at all, did we did not often find the skins they have cast off.

A day or two before the skin is to be changed, the animal appears more sluggish than usual, takes no notice of the worms you give it, which at other times it devours greedily; the skin in some places appears loose from the body, and its colour not so lively as it did before; and thus it continues till the great work of putting off the old skin is to be performed. It begins this operation by loosening with its fore feet the skin about its jaws, which, when open, are wider than any part of its own body, and pushes it backward gently and gradually both above and below the head, till it is able to slip out first one leg, and then the other; which when it has done, it proceeds to thrust the skin backward as far as these legs can reach; it is then obliged to rub its body against pebbles, gravel, or whatever else it can meet with, till more than half its body is freed from the skin, which appears doubled back, and covering the hinder part of the body and the tail. When the business is thus far done, the animal, turning its head round to meet its tail, takes hold of the skin with its mouth, and setting its feet on it, by degrees pulls it quite off, the hind legs being drawn out as the fore ones were before.

This operation sometimes takes up near half an hour, after which it appears full of life and vigour, as well as very sleek and beautiful. When the skin is come off, if it be not taken away soon, it is very common for the creature to swallow it whole, as it does all its other food; and if it take it in by the head-part first as frequently is the case, the tail-part, being filled with air and water, becomes like a blown bladder, and

proves so unmanageable that it is very diverting to see the pains it costs to discharge the air and water, and reduce it to a fit condition to be got down its throat.

Many creatures of very different kinds put off their skins and shells at certain periods. All serpents are supposed to do so; the skins of several kinds being often found whole. Crabs, lobsters, cray-fish, shrimps, and, probably, most or all of the crustaceous fishes, cast their shells from time to time; and if we may guess of the rest by the fresh-water shrimp, which Mr. B. had kept several times and observed, their shells are put off without any other breach than one, longitudinally, in the middle of the belly part, through which the body, tail, and claws are drawn out, and the shell left in a manner whole.

Of the insect tribe, every caterpillar has three or four skins, before its change into the aurelia state, in which the place of creeping out is a little below the head. The spider throws off the skin or shell three or four times, getting out of it by a rupture underneath, and leaving every claw, and even the horny covering of his forceps, entire. Even the little mite casts its skin also at several short periods, and nearly in the same manner.

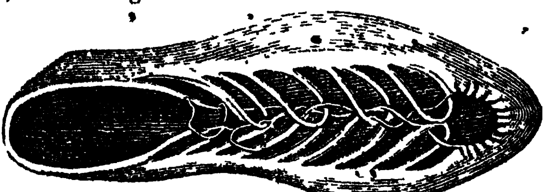
A Letter from Mr. G. Stovin, concerning the Body of a Woman, and an Antique Shoe, found in a Morass in the Isle of Axholm.

The beginning of June last (1747), a labouring man, of Amcotts, in the Isle of Axholm, in the county of Lincoln, was digging turf or peat in the moors of Amcotts; and, about six feet below the surface, his spade cut the toe of a sandal. Hearing of this discovery, Mr. S. found the other sandal, whole and firm. It was very soft and pliable, and of a tawny colour, with all the bones of that foot in it, and all the gristly part of the heel. Proceeding further, they found the skin and thigh-bones, which he measured, and found to be 18 inches long. They then found all the skin of the lower parts of the body, which was of the same colour as the sandals, and very soft. The skin drew or stretched like a piece of doe-leather, and was as strong. They then found the skin of the arms, which was like the top of a muff or glove, when the bones were shaken out. They then found the skin of a hand, with the nails as fresh as any person's living: this was the woman's natural skin so tanned, with the nails.

These sandals must be very ancient, and have most certainly been made of a raw hide, as they and the skin of the woman

were both of one colour, and both had one tanner; which, probably, is the moor water; which is exactly of the colour of coffee; and made so by such great quantities of oak and fir-wood, that are frequently dug out of these moors; several oak-trees affording 1000 pales for fencing, 5½ feet long, and six to eight inches broad, which oak-wood is as black as jet. The fir-wood retains it turpentine smell, and in hot weather, exposed to the sun, the turpentine will drop from it. This wood is frequently split into laths for the roofs of houses or floors; and it is remarkable that no worm will touch them. They frequently find also hazle-nuts and fir-apples in abundance; which is a plain proof that the trees fell in autumn, when the fruits were at maturity. This woman was probably overwhelmed by some strong eddy of water; for she lay on one side bended, with her head and feet almost together

The sandal is of one piece of leather, with a seam at the heel, and a thong of the same leather.



As to this water, on these moors, preserving human bodies; it is most certain, from part of a body having been taken up at Geel by Mr. Empson 50 or 60 years ago, and one in the great moor near Thorn, about seven years ago, with the skin like tanned leather, the hair, teeth, and nails being quite fresh.

On the Case of Margaret Cutting, who spoke distinctly, though she had lost the Apex and Body of her Tongue. By JAMES PARSONS, *M.D. F.R.S.*

SEVERAL of the members of the Royal Society having been divided in their opinions concerning what was reported of Margaret Cutting, when they were first informed of her by Mr. Baker, Dr. P. conceived it to be necessary, in order to render her case better understood, to lay before the Society the following particulars, which were the result of an examination made a few days before by Dr. Milward and himself, and which in general differs not from the opinion which that learned gentleman and he mentioned to the Society, on the

occasion, which the science of anatomy necessarily suggested to them at that time. But James Theobald, Esq. a member of the Royal Society, having encouraged her to come to London, and having brought her to the meeting of the Society, this gave all the members here an opportunity of coming at the truth of her case; wherefore Dr. P. here offers, first, an account of her then condition; and, next, some considerations on the natural state and uses of the tongue; which will show how far she makes the lips and teeth supply the want of her tongue in speaking, and also enable others to judge better of the case.

Of the state of the woman's tongue in December, 1747.—The apex and body of the tongue being the only parts that naturally fill the cavity of the mouth, are entirely wanting in this woman, as closely to the region of the os hyoides, which is the root of the tongue, as can well be conceived; and which was then situated too low in the throat to be perceived, even when she opened her mouth at the widest.

If the mortification had reached the os hyoides, it must have reached and destroyed the muscles of the larynx, and then the voice would have been destroyed; and also those of the pharynx, and then deglutition could never have been performed; the dreadful consequences of which need not be enumerated here; but she swallows well, and her voice is perfect, and therefore it is not very extraordinary she should command her voice by the proper muscles which remain untouched.

She had her taste perfectly, which is hereafter accounted for.

The tongue is a fleshy substance, chiefly made up of muscles, and consists of a basis or root, a body, and an apex. As to its uses, it is said to be the instrument of speaking and tasting. As to the latter, experience shows us the very apex of the tongue is less capable of discerning tastes than the next part to it, and this than the parts yet farther back, all along the body to the root.

As to speech, which is only sound or voice articulated into expression, the tongue is not the sole organ for such articulation; the lips, teeth, and root of the mouth are instruments also for the same purpose; the two latter for the necessary resistance to the apex of the tongue, and the lips for the absolute articulation and pronunciation of many letters: however, the following short examination of the letters of the alphabet, as expressed by these organs, will demonstrate it. The tongue expresses some letters with its apex, and some with its root. Those absolutely proper to the apex are only

five. d, l, n, r, t. And those to which it only assists, are the following letters, c, g, s, x, z ; all which can be performed with the teeth alone, and which this person did very well.

Now the lip-letters, and those expressed by the root of the tongue, she also performed as well as any person ; the former are b, f, m, p ; and the latter are k, q, x ; and as to the vowels, and the aspiration h, since they are chiefly sounded by the exhalation of the voice, commanded partly by the lips in widening or straitening the capacity of the mouth, these she could also express ; so that there was no letters she could not pronounce, except the five apex letters ; and these she managed so well by bringing the under lip to her upper teeth, in the course of her conversation, that any one could instantly apprehend every word she said ; and she further plainly proved, that the lips are a better succedaneum to the apex, than that could be to the lips if they were wanting.

An Account of the Experiments made to discover whether the Electrical Power, when the Conductors of it were not supported by Electrics per se, would be sensible at great Distances : with an Enquiry concerning the respective Velocities of Electricity and Sound By WILLIAM WATSON, *F.R.S*

AMONG the many surprising properties of electricity, none was more remarkable, than that the electrical power, accumulated in any non-electric matter contained in a glass phial, described on its explosion a circuit through any line of substances non-electrical in a considerable degree ; if one end of it was in contact with the external surface of this phial, and the other end on the explosion touched either the electrified gun-barrel, to which the phial in charging was usually connected, or the iron hook always fitted in it. This circuit, where the non-electric substances, which happen to be between the outside of the phial and its hook, conduct electricity equally well, is always described in the shortest route possible ; but if they conduct differently, this circuit is always formed through the best conductor, how great soever its length is, rather than through one which conducts not so well, though of much less extent.

Mons. le Monnier the younger, at Paris, in an account transmitted to the Royal Society, takes notice of his feeling the stroke of the electrified phial along the water of two of the basins of the Thuilleries, the surface of one of which is about an acre, by means of an iron chain which lay on the ground, and was stretched round half their circumference. On these

considerations it was conjectured, as no circuit had as yet been found large enough so to dissipate the electrical power as not to make it perceptible, that if the non-electrical conductors were properly disposed, an observer might be made sensible of the electrical commotion quite across the river Thames, by the communication of no other medium than the water of that river. In any other part of natural philosophy, as we should draw conclusions only from the facts themselves, it was determined to make the experiment.

To try this experiment it was absolutely necessary that a line of non-electric matter, equal in length to the breadth of the river, should be laid over it, so as not to touch the water in any part of its length; and the bridge at Westminster was thought the most proper for that purpose, where the water from shore to shore is somewhat more than 400 yards.

Accordingly, on July 14, 1747, several members of the Royal Society met to assist in making the experiment. A line of wire was laid along the bridge, not only through its whole length, but likewise turning at the abutments, reached down the stone steps on each side of the river low enough for an observer to dip into the water an iron rod held in his hand. One of the company then stood on the steps of the Westminster shore, holding this wire in his left hand, and an iron rod touching the water in his right; on the steps facing the former, on the Surrey shore, another of the company took hold of the wire with his right hand, and grasped with his left a large phial almost filled with filings of iron, coated with sheet-lead, and highly electrified by a glass globe properly disposed in a neighbouring house. A third observer, standing near the second, dipped an iron rod held in his left hand into the water, and touching the iron hook of the charged phial with a finger of his right hand, the electricity snapped, and its commotion was felt by all the three observers, but much more by those on the Surrey shore.

The experiment was repeated several times, both then and afterward, and the electrical commotion felt across the river. The length of this circuit, through which the electricity was propagated, was at least 800 yards, more than 400 yards of which was formed by the stream of the river.

It was thought proper to try the effects of electricity on some warm spirit of wine through the large circuit before mentioned. Accordingly, the observers being placed as before, both on the Westminster and Surrey shores, no other alteration was made in the before-mentioned apparatus, than that the

wire which connected the gun-barrel with the iron hook of the coated phial being laid aside, the coated phial itself was charged at the gun-barrel, and then brought in the hands of an observer near the warm spirits in the spoon, which was placed on the short iron rod before mentioned, which was connected with the wire which went to the observers on the Surrey shore. On presenting properly the iron hook of the charged phial to the warm spirit, it was instantly fired, and the electrical commotion felt by the observers on both sides of the river.

Encouraged by the success of these trials, the gentlemen were desirous of continuing their enquiries, and of knowing whether the electrical commotions were perceptible at a still greater distance. The New River near Stoke Newington was thought most convenient for that purpose; as at the bottom of that town, the windings of the river are such, that the distance by land is about 800 feet, but the course of the river is near 2000. From another place in a right line is 2800 feet, but the course of the water is near 8000 feet.

Consequently, on Friday, July 21. 1717, there met at Stoke Newington, the President of the Royal Society and several other gentlemen; where every thing was disposed as before, and the wire extended over the meadows, without touching the water. When every thing was thus arranged, and the signals given, the charged phial was exploded several times, and the electrical commotion every time smartly felt by the observers at both places. In the like trials at the other places, the commotions were perceptible at a distance not less than 2800 feet by land, and near 8000 by water.

The gentlemen met again, July 28. 1747; when the iron wire in its whole length being supported, without any where touching the ground, by dry sticks placed at proper intervals, of about three feet in height, the observers both stood on originally-electrics, and, on the signal, dipped their iron rods into the water. On discharging the phial, which was several times done, they were both very much shocked, much more so than when the conducting wire lay on the ground, and the observers stood on it, as in the former experiments.

The gentlemen were desirous of trying the electrical commotion, at a still greater distance than any of the former, through the water, and where, at the same time by altering the disposition of the apparatus, it might be tried, whether that power would be perceptible through the dry ground only at a considerable distance. Highbury Barn beyond Islington was thought a convenient place for this purpose, as it was

situated on a hill nearly in a line, and almost equi-distant from two stations on the New River, somewhat more than a mile asunder by land, though following the course of that river their distance from each other was two miles. The hill between these stations was of a gravelly soil; which, from the late continuance of hot weather without rain, was dry, full of cracks, and consequently was as proper to determine whether the electricity would be conducted by dry ground to any great distance, as could be desired. Accordingly, on Wednesday, Aug. 5. 1747, they met at Highbury Barn. The electrifying machine being placed up one pair of the stairs in the house there, a wire from the coated phial was conducted on dry sticks as before to that station by the side of the New River, which was to the northward of the house. The length of this wire was three furlongs and six chains, or 2376 feet. Another wire fastened to the iron bar, with which, in making the explosion, the gun-barrel was touched, was conducted in like manner to the station on the New River to the southward of the house. The length of this wire was four furlongs, five chains, and two poles, or 3003 feet. The length of both wires, exclusive of their turnings round the sticks, was one mile, one chain, and two poles, or 5379 feet.

At this distance the gentlemen proposed to try, first, whether the electrical commotion was perceptible, if both the observers, supported by originally-electrics, touched the conducting wire with one hand, and the water of the New River with an iron rod held in the other?

Several explosions were made with the observers touching the water, and standing on wax, with their iron rods in the water; when the observers at both stations felt the electrical shock.

By the experiments of this day, the gentlemen were satisfied that the dry gravelly ground conducted the electricity as strongly as water; which, though otherwise at first conjectured, they now found not to be necessary to convey that power to great distances; as well as that, from difference of distance only, the force of the electrical commotion was very little, if at all impaired.

From the shocks which the gentlemen received in their bodies, when the electrical power was conducted on dry sticks, they were of opinion, that from difference of distance simply considered, as far as they had yet experienced, the force was very little if at all impaired. When they stood on originally-electrics, and touched the water or ground with an iron rod, the electrical commotion was always felt in their

arms and wrists; when they stood on the ground, and touched either the water or ground with their iron rods, they felt the shock in their elbows, wrists, and ankles; when they stood on the ground without the rod, the shock was always in the elbow and wrist of that hand which held the conducting wire, and in both ankles. The observers here being sensible of the electrical commotion in different parts of their bodies, was owing in the first instance to the whole of it passing, because the observer stood on wax, through their arms, and through the iron rod; in the second, when they stood on the ground, the electricity passed both through their legs and through the iron; in the third, when they stood on the ground without either wax or rod, the electricity directed its way through one arm, and through both legs to complete the circuit.

The gentlemen were desirous of closing the present enquiry, by examining not only whether the electrical commotions were perceptible at double the distance of the last experiments in ground perfectly dry, and where no water was near; but also, if possible, to distinguish the respective velocities of electricity and sound. Shooter's Hill was chosen, as the most convenient place. As only one shower of rain had fallen during the preceding five weeks, the ground could not but be very dry; and as no water was near, if the electrical commotion was felt by the observers at the stations, it might be safely concluded, that water had no share in conducting it.

Accordingly, August 14. 1747, they met at Shooter's Hill for this purpose. It was here determined to make 12 explosions of the coated phial, with an observer placed at the seven-mile stone, and another at the nine-mile stone, both standing on wax, and touching the ground with an iron rod. This number of explosions was thought the more necessary, as the observers at these stations were not only to examine whether the electricity would be propagated to so great a distance, but if it were, the observer at the seven-mile stone was by a second watch to take notice of the time lapsed between feeling the electrical commotion, and hearing the report of a gun fired near the machine, as close as might be to the instant of making the explosion; and, therefore, to examine this matter with the requisite exactness, this number of explosions should be made.

To execute this, the electrifying machine was placed up one pair of stairs in a house on the west side of Shooter's Hill, and a wire from the short iron rod, with which the gun-

barrel was touched in making the explosions, was conducted on dry sticks as before into a field near the seven-mile stone. The length of this wire, exclusive of its turnings round the sticks, was a mile, a quarter, and eight poles, or 6732 feet. In great part of this space it was found very difficult to support the wire, on account of their scarcely being able to fix the sticks in the strong gravel there almost without any cover of soil; nor could the wire in some places be prevented from touching the brambles and bushes, nor in one field the ripe barley.

Another wire was likewise conducted on sticks from the coated phial to the nine-mile stone. In this space, the soil being a strong clay, the wire was very well secured, and in its whole length did not touch the bushes The length of this wire was 3868 feet. As much as the place, where the observers were stationed in a corn-field, was nearer the machine than the seven-mile stone, so much were the other observers placed beyond the nine-mile stone, that their distance from each other might be two miles. The 40 feet of wire in these two measures exceeding two miles, was what connected the short iron rod before mentioned, and the coated phial, with their respective conducting wires.

The observers being placed at their respective stations, the observer at the machine proceeded in making the explosions of the coated phial; by which the observers at the nine-mile stone were very strongly shocked; and they were also felt at the seven-mile stone. This demonstrated that the circuit here formed by the electricity was four miles, viz. two miles of wire, and two miles of ground, the space between the extremities of that wire. A distance without trial too great to be credited! how much farther the electrical commotion will be perceptible, future observations can only determine.

The electrical commotion by the observers near the seven-mile stone was but slightly felt; nor could it be otherwise expected, the wire in many parts of its length touching, as was before mentioned, the moist vegetables; which, in as many places as they were touched, formed subordinate circuits. We find, in all other instances, that the whole quantity of electricity, accumulated in the coated phial, is felt equally through the whole circuit, when every part is in a great degree non-electric; so here the whole quantity, or nearly so, determined that way, was felt by the observers at the nine-mile stone; while those at the other station felt so much of their quantity only as did not go through the vegetables;

that is, that proportion only in which iron is a greater non-electric than the vegetables.

Though the electrical commotions, felt by the observers near the seven-mile stone, were not strong, they were equally conclusive in showing the difference between the respective velocities of electricity and sound.

The length of the conducting wire from the machine to the observers near the seven-mile stone was 6732 feet; the length of that to the nine-mile stone, 3868 feet. The first of these measures only was made use of in the present operations concerning the velocity of electricity. In 12 discharges of the coated phial, which were felt by the observers near the seven-mile stone, and who, by a second watch of Mr. Graham's, measured the time between feeling the electrical commotion and hearing the report of the gun, with the utmost attention and exactness, was at a medium 5' seconds. And as the gun was distant from these observers 6732 feet, it follows, from the experiments, which have been made on the velocity of sound, that the real instant of the discharge of the gun preceded that of the observers hearing its report, at this time, when the strength of the wind was not so great as to enter into the computation, $6\frac{830}{1000}''$; or preceded the instant when the electrical commotion was felt only $0\frac{837}{1000}''$. But this instant was, from the nature of the experiment, necessarily prior to that of the electrical explosion, which was not made till the fire of the gun was actually seen; and therefore the time between the making of that explosion and its being actually felt by the observer, which must have been less than $0\frac{837}{1000}''$. was really so small, as not to fall under any certain observation, when it is to be distinguished from that which must of necessity be lost, between the firing of the gun and the electrical explosion itself.

The gentlemen concerned were still desirous, if possible, of ascertaining the absolute velocity of electricity at a certain distance; because, though last year in measuring the respective velocities of electricity and sound, the time of its progress was found to be very little, yet they were desirous of knowing, small as that time was, whether it was measureable; and Mr. W. had thought of another method for this purpose.

Accordingly, Aug. 5. 1748, there met at Shooter's Hill for this purpose the President of the Royal Society and several other gentlemen; when it was agreed to make the electrical circuit of two miles, in the middle of which an observer was to take in each hand one of the extremities of

a wire, which was a mile in length These wires were to be so disposed that, this observer being placed on the floor of the room near the electrifying machine, the other observers might be able in the same view to see the explosion of the charged phial and the observer holding the wires, and might take notice of the time lapsed between the discharging the phial and the convulsive motions of the arms of the observer in consequence of it; as this time would show the velocity of electricity, through a space equal to the length of the wire between the coated phial and this observer.

When all parts of the apparatus were properly disposed, several explosions of the charged phial were made; and it was invariably seen, that the observer, holding in each hand one of the extremities of these wires, was convulsed in both his arms in the instant of making the explosions. Instead of one, four men were then placed holding each other by the hand near the machine, the first of which held in his right hand one extremity of the wire, and the last man the other in his left They were all seen convulsed in the instant of the explosion. Every one who felt it complained of the severity of the shock. It was then tried whether, as the ground was wet, if the explosion was made with the observer holding the extremity of each wire standing on the ground near the window of the house, any difference would arise in the success of the experiment: no difference was found, the observer being shocked in the instant of the explosion as before in both his arms, and across his breast. On these considerations they were fully satisfied, that through the whole length of this wire, being 12,276 feet, the velocity of electricity was instantaneous.

Of the Giants' Causeway in Ireland. By the Rev. RICHARD POCOCKE, *LL.D.*

THE sea-cliffs are very high in the vicinity, but what is called the Causeway is a low head, extending from the foot of the cliffs into the sea like a mole. This head does not appear at first so grand as it is represented in the views engraved of it; but when one comes to walk upon it, and consider it more attentively, it appears to be a stupendous production of nature. The head ends in two points: Dr. P. measured the more western to the distance of 360 feet from the cliff, and it appeared to extend about 60 feet farther, which he could not measure, as the sea was then high; and at low tides it might be seen about 60 feet yet farther, on a descent losing

itself in the sea. He also measured the more eastern point 540 feet from the cliff, and saw about as much more of it as of the other, when it winds about to the eastward, and is also lost in the water. One may walk on this head on the tops of the pillars to the edge of the water. These pillars are of all angular shapes, from three sides to eight. The eastern point, towards that end where it joins the rocks, terminates for some way in a perpendicular cliff, formed by the upright sides of the pillars, some of which he measured, and found to be 33 feet four inches in height. They say there are in all 74 different sorts of figures among them. Each pillar consists of several joints or stones lying one upon another, from six inches to about a foot in thickness: some of these joints are in the middle so convex, as for those prominences to be nearly quarters of spheres, round each of which is a ledge, on which the stones above them have rested, every stone being concave on the under side, and fitting in the exactest manner on that which lies next below it. The pillars are from one to two feet in diameter, and consist most commonly of about 40 joints, most of which separate very easily, though some others, which are more deeply indented into each other, cohere strongly enough to bear being taken away in pairs.

But the Causeway is not, he thinks, the most singular part of this extraordinary curiosity, the appearance of the cliffs themselves being yet more surprising: these and their several strata he examined from the rocks on the other side of a little bay, about half a mile to the east of the Causeway. He thence observed, that there runs all the way a stratum from the bottom, of black stone, to the height of about 60 feet, divided perpendicularly at unequal distances by stripes of a reddish stone, looking like cement, and about four or five inches in thickness. On this there is another stratum of the same black stone, divided from it by a stratum five inches thick of the red. Over this another stratum of stone 10 feet thick, divided in the same manner; then a stratum of the red stone 20 feet deep; and above that a stratum of upright pillars. Above these pillars lies another stratum of black stone 20 feet high; and above this is again another stratum of upright pillars rising in some places to the top of the cliffs, in others not so high, and in others again above it, where they are called the Chimneys.

This face of the cliffs reaches for two computed miles east from the Causeway, that is about three measured English miles, to two miles west of Balintoy. The upper pillars seem

to end over the Causeway, and he thinks become shorter and shorter as one goes from it, lying between two binds of stone like seams of coal, and like those little pillars found in Derbyshire. These binds probably meet together all round, and inclose this extraordinary work of nature; and if so, the pillars must be very short towards the extremities.

When on the Causeway, he saw in the cliff, to the south-east, what they call the Organs, about a quarter of a mile off, and a third part of the way up the cliff. They appeared small, and somewhat like black stalactites: they were not commonly known to be such pillars as the others; but they are so, and belong to the lower stratum. When with great difficulty he climbed up the steep hill to them, he found they were hexagonal, and larger pillars than most of the others, being about two feet in diameter; and he measured five sides of one of them, which were of 13, 15, 12, 21, and 16 inches respectively. The joints he could come at were about nine inches thick, and each pillar consisted of between 40 or 50 of them: these joints are almost flat and plain, the convexities on their upper faces being so small as to be scarcely discernible. He enquired whether any of these pillars were found in the quarries within land, and the people there told him they were not: but he has since been assured by others, that there are some found two or three miles from the shore.

On the Everlasting Fire in Persia. By Dr. James Mounsey.

As the natural history of Persia is but little known, and the authors of the Universal History have given no true account of the everlasting sacred fire which the Gauers worship, Dr. M. gives the following description of it: —

This perpetual fire rises out of the ground in the peninsula of Abscheron, about 20 miles from Baku, and three miles from the Caspian shore. The ground is very rocky, but has a shallow covering of earth over it. If a little of the surface be scraped off, and fire be applied to the hollow, it catches immediately, and burns without intermission, and almost without consumption; nor is ever extinguished, unless some cold earth be thrown over it, by which it is easily put out.

There is a spot of ground, about two English miles broad, which has this very wonderful property; and here is a caravansary, round which are many places where the earth continually burns; but the most remarkable is a hole about four feet deep, and 14 feet in diameter. In this caravansary live 12 Indian priests, and other devotees, who worship

the fire, which, according to their traditions, has burnt many thousand years. It is a very old vaulted building, and in its walls are a great many chinks, to which, if a candle be applied, the fire catches instantaneously, and runs instantly wherever the chinks communicate; but it may be easily extinguished. They have hollow places in the house fitted to their pots, which they boil without any other fuel; and instead of candles they stick reeds into the ground; from the tops of which, on applying fire to them, a white flame immediately comes forth, and continues to burn without consuming the reeds, till they think proper to extinguish it, by putting little covers over them for that purpose.

About an English mile and a half from this place there are wells of white naphtha, which is exceedingly inflammable; and though the flame of naphtha affords both smoke and smell, it is highly probable the perpetual fire just described is owing to naphtha, but so purified, in filtering through the stone, that it becomes divested of all such particles as produce smoke or smell. The stone and earth are grey in colour, and saltish to the taste; and indeed much salt is found on this peninsula of Abscheron. There is also a salt lake, near the side of which the white naphtha flows by five different springs. This naphtha is made use of only for medicinal purposes. It is yellowish from the spring, but when distilled resembles spirits of wine. They give it internally for gonorrhœas, disorders of the breast, and for the stone, and they apply it externally in gouty cases, and contractions of the sinews. Black naphtha is produced eight or nine miles from the perpetual fire: it is thick, and being distilled becomes not clear, but yellow. The best, and greatest plenty, is at Balachame, where there are above 50 springs, the greatest producing every day 500 batman, each batman containing ten Russ pounds, which are somewhat less than English weight.

Of the Locusts, which did vast Damage in Wallachia, Moldavia, and Transilvania, in 1747–8.

The first swarms entered into Transilvania in August, 1747; these were succeeded by others, which were so surprisingly numerous, that when they reached the Red Tower, they were full four hours in their passage over that place; and they flew so close, that they made a sort of noise in the air, by the beating of their wings against each other. The width of the swarm was some hundreds of fathoms, and its height or density may be easily imagined to be more considerable, inasmuch as they hid the sun, and darkened the sky, even to

that degree, when they flew low, that people could not know one another at the distance of 20 paces. But as they were to fly over a river that runs in the vallies of the Red Tower, and could find neither resting-place nor food; being at length tired with their flight, one part of them lighted on the unripe corn on this side of the Red Tower, such as millet, Turkish wheat, &c.; another part pitched on a low wood: where having miserably wasted the produce of the land, they continued their journey, as if a signal had been actually given for a march The guards of the Red Tower attempted to stop their irruption into Transilvania by firing at them; and indeed where the balls and shot swept through the swarm, they gave way and divided; but, having filled up their ranks in a moment, they proceeded on their journey.

Wherever those swarms happened to pitch, they spared no sort of vegetable; they ate up the young corn, and the very grass; but nothing was more dismal to behold than the lands in which they were hatched; for they so greedily devoured every green thing there, before they could fly, that they left the ground quite bare.

On the Lacrymæ Batavicæ, or Glass Drops. By CLAUD. NIC. LE CAT. M.D. F.R.S.

THE glass-tear, or drop, commonly called lacryma Batavica, or lacryma Borussica, because it was first made in these countries, is much celebrated among natural philosophers, on account of the singular phenomena which it exhibits, and which have for a long time exercised their sagacity. The make of this drop is as simple as its explanation is difficult. It is the work of the meanest workmen in a glass-house. On the top of an iron rod they take up a small quantity of the matter of glass in fusion: they let it drop into a pail of water: the drop makes that part of the water which it touches to boil with a hissing noise, as red-hot iron does, which it resembles in that instant; and when it does not break in this operation, as it most frequently does, it forms a little pyramidal mass, which is known by the name of a glass-drop.

The drop is of such hardness and resistance, that it bears smart blows of a hammer, without breaking. Yet if you grind the surface of this drop which resisted the hammer, or if you only break the tip of the small end or tail, the whole shatters into powder. This shattering of the drops is attended with a loud report; and the dust or powder, to which it is reduced, is extensively scattered all around. If the drop be

ground with powder of emery, imbibed with oil, it often escapes breaking. If this experiment be made in the air-pump, the drop busts with greater impetuosity, so as sometimes to break the receiver; and its dust is finer than when done in the open air; and if it be made in the dark, the drop in bursting produce a small light. If this drop be annealed in the fire it looses all these singularities; and being reduced to the state of common glass, it easily breaks under the hammer; and does not burst on breaking the small end. The drops that are made by letting them cool in the air produce no other effects than those which have been annealed.

The first natural philosophers who endeavoured to investigate the cause of this phenomena, imagined that they found it in the air. Some of them supposed, that this air was shut up in the drop by the crust which the cold water forms on its surface while it is yet red-hot; and attributed its rupture to the violence with which this air issued through the too narrow passage made for it, in breaking the small end of the drop. Others maintained, on the contrary, that the drop, in this state, contained no air at all, nor any thing but particles of fire, or subtile matter; in short, a mere vacuum as to air; and that the sudden bursting of the drop was occasioned by the impetuous entry of the air into this kind of vacuum.

It is among the glass-workers, and in their art, that the secret of the glass-drop is to be sought; and there it is that he discovered it. Those who have seen glass-houses know, that when a piece fails in the hands of a workman, he throws it aside; and this piece is not long exposed to the air before it breaks in pieces; and when the same workman has succeeded in making a piece, and is willing to preserve it, he takes great care not to let it cool in the air; but carries it hot into another oven of a moderate heat, where he leaves it for a certain time; and this last operation is called annealing the glass.

A natural philosopher who is witness to this managment, ought to enquire into the reasons and necessity of it. How comes it that the glass which cools in the air breaks, and when it has been annealed, it does not break? This is the reason. A bit of melted glass, red-hot and liquid at the same time, is in that state, purely because its particles are divided by fire, or so violently agitated, that these component parts of the glass hardly touch each other.

When this substance is exposed to the air, the coolness of this fluid, which touches the surface of the glass, cools that surface first; that is, brings the particles nearer together,

braces their pores, and thus imprisons the crystals, which still fill the inside of this substance. While these fired particles find pores enough on the surface to move freely, the glass continues whole; but when the glass grows colder, that is, when the pores of its surface begin to confine these fired particles, then their whole action is exerted against the parts of the glass, which they break into a thousand pieces.

Letter from LEONARD EULER, *Prof. Math. at Berlin, and F.R.S. concerning the gradual Approach of the Earth to the Sun.*

M. LE MONNIER writes to me, that there is at Leyden an Arabic manuscript of Ibn Jounis, which contains a history of astronomical observations. I am very impatient to see such a work which contains observations that are not so old as those recorded by Ptolemy. For having carefully examined the modern observations of the sun with those of some centuries past, though I have not gone farther back than the 15th century, in which I have found Walther's observations made at Nuremberg, yet I have observed that the motion of the sun, or of the earth, is sensibly accelerated since that time, so that the years are shorter at present than formerly; the reason of which is very natural: for if the earth, in its motion, suffers some little resistance, which cannot be doubted, the effect of this resistance will gradually bring the planets nearer and nearer the sun; and as their orbits thus become less, their periodical times will also be diminished. Thus in time the earth ought to come within the region of Venus, and at last into that of Mercury, where it would necessarily be burnt. Hence it is manifest that the system of the planets cannot last for ever in its present state. It also incontestably follows, that this system must have had a beginning: for whoever denies it must grant that there was a time when the earth was at the distance of Saturn, and even farther, and, consequently, that no living creature could subsist there.

Letter from Mr. Professor EULER *concerning the Contraction of the Orbits of the Planets.*

I AM still thoroughly convinced of the truth of what I advanced, that the orbs of the planets continue to be contracted, and, consequently, their periodical times grow shorter.

The late Dr. Halley had also remarked, that the revolu-

tions of the moon are quicker at present than they were in the time of the ancient Chaldeans, who have left us some observations of eclipses. But as we measure the length of years by the number of days, and parts of a day, which are contained in each of them, it is a new question, whether the days, or the revolutions of the earth round its axis, have always been of the same length.

At present we measure the duration of a day by the number of oscillations which a pendulum of a given length makes in this space of time. But even though the ancients had actually made such experiments, we could draw no inferences from them, without supposing, that gravity, on which the time of an oscillation depends, has always been of the same force; but who will ever be in a condition to prove this invariability in gravity? Thus, even supposing that the days had suffered considerable changes, and that gravity had been altered suitably to them, so that the same pendulum had always completed the same number of vibrations in a day, it would, nevertheless, be still impossible for us to perceive this inequality were it ever so great. And yet I have some reasons, deduced from Jupiter's action on the earth, to think, that the earth's revolution round its axis continually becomes more and more rapid.

New Discoveries relating to the History of Coral. By Dr. Vitaliano Donati.

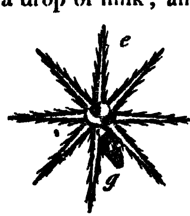
Coral is a marine vegetation, in shape nearly resembling a shrub stripped of its leaves. It has no roots, but is supported on a broad foot, or basis, which adapts itself like wax, and sticks to any body in all its parts, so firmly, that it is impossible to disengage it. The shape of this foot is not always the same; but it mostly approaches to rotundity. Its use is to hold the coral fixed, and support it; not to nourish it: since there are found pieces of coral, with their feet broken off, which nevertheless continue to live, to grow, and to propagate, at the bottom of the sea. From this foot arises a trunk, generally single, the greatest thickness of which seldom exceeds an inch.

The substance of the coral gives way to the cellule by small cavities: yet these are not very visible in the old thick branches, but they are pretty easily seen in the young and slender. Thus the cellule does not end at the coralline

substance; since the white pellicle is between it and the said substance. The hollow of the cellule grows narrow into a sort of cone, with an obtuse apex; the belly of which is greater in diameter than the basis. The bottom of such a cellule faces the foot of the coral, and its mouth the branchy or most distant part from the foot. In this cellule is lodged the polypus, which is visible to the naked eye, but its exact shape is only to be seen by the microscope; and it was by this means, that a drawing has been made of it.

From each cellule a white, soft, and somewhat transparent polypus comes forth, or extends itself; which in shape resembles a star with eight equal rays, nearly conical, and furnished with other conical appendices, *a a*, which issue out of it on both sides. The two rows of these have their direction nearly on the same plane. The rays are somewhat flattened, and a trough rises out of their centre, somewhat widened at its beginning, with an opening or great mouth at top, *n*. In its sides there are eight upright ridges, broad and elevated, and as many wrinkles or furrows; and each ray is inserted between every two wrinkles, *a*, *a*. This trough is placed on a smooth part, *g*, which we may call the belly of the animal.

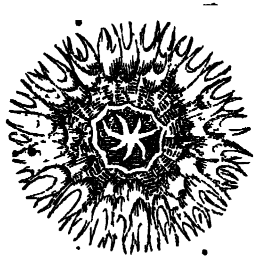
It is in this position that the polypus is seen the moment the coral is drawn out of the sea. The polypus, in this contracted state, seen without a microscope, resembles a drop of milk; and this is what all the good coral-fishers take for the real milk of the coral; the rather, because, by pressing the bark of the coral with the fingers, the polypus is forced out, and in coming forth it always retains the appearance of milk.



While the first cellule is shut up, or the egg of the coral is in its substance, we do not find any one hard part in it like bone or marble; it is all soft: but afterwards, when the cellule opens, we begin to observe some hard lamellæ; and when it is grown larger, and arrived at the height of about a

line and a half, it widens at bottom and at the top, and grows narrower in the middle, assuming the proper consistence and hardness of coral. And as this grows, the polypi are multiplied, and new branches of coral are formed. Here then we see the vegetation of a plant, and the propagation of an animal.

The madrepora is entirely like the coral, as to its hardness, which is equal to bone or marble. Its colour is white, when polished. Its surface is lightly wrinkled, and the wrinkles run lengthwise of the branches. Its inside is of a particular organisation; having in the centre a sort of cylinder, which is often pierced through its whole length by two or three holes. From this cylinder are detached about 17 laminæ, which run to the circumference in straight lines.



In every one of the cellules is found a polypus here represented, but considerably magnified; the mechanism of which is this: three different parts, unlike each other, compose this animal; viz. the feet, a trough, and a head.

On the Class of the Phocæ Marinæ. By James Parsons, M.D. F.R.S.

All the species of phocæ, this being the generical name, have among them a very great likeness to each other, in the shape, not only of their heads, but also of their bodies and extremities. They are webbed nearly alike, are alike reptile,

viviparous, bringing forth, suckling, and supporting their young alike; and, in fine, all have the same title to these appellations, phocæ, vitulus marinus, sea-cow, sea-lion, &c.; and these names are vulgarly given to them, as their size happens to be greater or smaller.

The different species of this class, or rather genus, of animals, are distinguishable, by their proportion, their size, as to their full growth, their teeth, webbed feet, and whatever other parts in some may not be proper to others.

Their size, as to the utmost growth of an adult, is every different. I have seen one which was 7½ feet in length; and, being very young, had scarcely any teeth at all. One now in London is about three feet long, is very thick in proportion, and has a well-grown set of teeth; which, in a great measure, shows this to be about its full growth. The manati is also a phoca, and is one of those species which grows to a prodigious size.

A governor, in the province of Nicaragua, had a young manati, which was brought to him, to be put into the lake Guanaibo, which was near his house; where he was kept during 26 years, and was usually fed with bread, and such-like fragments of victuals as people often feed fish with in a fish-pond. He became so familiar, by being daily visited and fed by the family, that he was said to excel even the dolphins, so much celebrated by the ancients, for their docility and tameness. The domestics of this governor named him Matto; and at whatever time of the day they called him by that name, he came out of the lake, took victuals out of their hands, crawled up to the house to feed, and played with the servants and children; and sometimes 10 persons together would mount upon his back, whom he carried with great ease and safety across the lake.

All that is here mentioned of the docility of the manati does not much surpass that of a seal now in London. He answers to the call of his keeper, and is observant of his commands; takes meat from his hand, crawls out of the water, and stretches at full length, when he is bid; and when ordered, returns into the water; and, in short, stretches out his neck to kiss his keeper, as often and as long as required. These are marks of a tractableness which one could hardly expect from animals, whose mien and aspect promise little, and indeed whose place of abode, being for the most part inaccessible, prevent their being familiarised to any commerce with men, except by mere chance.

The walrus, or mors, is another species of phoca, and differs

very little in shape and parts from the other species of this genus; except that the two canine teeth of the upper jaw are of a prodigious size, like the great teeth of an elephant.

Letter, dated May 2. 1750, from Mr. Freeman *at Naples, relating to the Ruins of Herculaneum.*

About seven or eight years ago, the discovery of Herculaneum was much spoken of, which was reported to have been swallowed up by a violent eruption of Mount Vesuvius, according to the last accounts, in the first year of the reign of Titus, 79 years after Christ.

You are first conducted down a narrow passage, scarcely wide enough for two persons to pass; and in a gradual slope, to the depth of about 65 feet perpendicular. Here is shown a great part of the ancient theatre, a building in the form of a horse-shoe. That part where the spectators sat is visible, and consists of 18 rows of broad stone seats, one above another, in a semicircular form. At proper distances within the circuit of the seats, through the whole range, from bottom to top, are little narrow flights of steps, by which the spectators might come to or go from their seats commodiously, without crowding. These steps or stairs also lead up, in a straight line, to a sort of gallery, several feet wide, which ranges all round the outside of the theatre, and is called the precinct; above which there are other stairs, which lead to a second. By this precinct it is judged that the theatre, with the orchestra, must be about 52 or 53 feet diameter.

There is another opening, distant from that which leads to the theatre, by which they have made a way into some houses. Here they seem to have dug infinitely more than about the theatre; for one may ramble, as in a labyrinth, for at least half a mile. Among the things that have been dug out of either of the two places are many parts of broken horses, with part of a triumphal car or chariot, all of gilt bronze; and which, they say, were placed over one of the gates of the theatre.

Two equestrian statues were found on each side of one of the said gates, and they suppose fronting a street that led to the theatre. One of these statues cannot be repaired; the other, which happened to be better preserved, is well repaired, and is set up under the piazza in the gateway of the king's palace at Portici.

Of busts, there are some very beautiful, as that of Jupiter Ammon, Neptune, Mercury, Juno, Ceres, Pallas, &c. In the apartments of the palace is a vast number of little statues,

many of which are extremely beautiful; also a great number of little idols, tripods, lachrymatories, and many vases curiously wrought. Among these, is a whole loaf of bread burnt to a coal; which they will not suffer any one to touch. It is covered with a glass bell, through which are perceived letters on the loaf, which possibly were the baker's mark.

Of the pictures, some were taken out of a temple near the theatre, others from the houses. They have all preserved their colours to admiration, which are very lively. They are painted in fresco, and were sawed out of the walls, with much trouble and care; and are now fixed with binding mortar, or cement, in shallow wooden cases to prevent their breaking, and varnished over to preserve their colours. You must think that these pictures are not alike valuable, otherwise than from their antiquity; some doubtless have been done by good hands, others by bad, as one sees by the works of those now-a-days.

There are many baskets and cases full of different things, all jumbled together; such as kitchen utensils, locks, bolts, rings, hinges, and all of brass. Things that were of iron, were totally eaten up with rust. When the workmen came to any thing of that sort, it mouldered to dust as soon as they touched it; occasioned, doubtless, by the dampness of the earth, and the many ages during which it lay buried. There were found many vases, and crystal bottles full of water; but that might penetrate through the earth and fall into them, if not close stopped: also a sort of standish or inkhorn, in which were found many stylets or pens, with which they wrote in those days. When it was first taken out, they say, the ink had not only its natural colour, but that it was yet capable of tinging: it is very dry now. There were eggs found quite whole, but empty; also nuts and almonds; grain of several sorts, beans and peas, burnt quite black. Many other sorts of fruit were found burnt quite to a coal, but whole.

Mr F. declares that he cannot be of the opinion of some, who assert that this city was suddenly swallowed up, which implies that the earth must have opened, and formed a pit to receive it. His opinion is, that it was overwhelmed with the matter issuing from the mountain, at the time of the irruption; because most things were found upright, chiefly the buildings.

The appearance of this city would greatly disappoint such as should have raised their expectation to see in it spacious streets and fronts of houses; for they would find nothing but long narrow passages, just high enough to walk upright in, with a basket on the head, and wide enough for the work-

men to pass each other, with the dirt they dig out. There is a vast number of these passages, cut one out of another; so that one might perhaps walk the space of two miles, by going up every turning.

A skeleton was found in a doorway, in a running attitude; with one arm extended, which appeared to have had a bag of money in the hand of it, for the lava had taken so exact an impression of the man, that there was a hole under the hand of the extended arm; which hole was apparently the impression of the bag, and several pieces of silver coin were found in it. This man, therefore, must have had notice enough of the danger, to endeavour to secure his treasure; though he must have been encompassed with liquid fire, in attempting it.

Observations on the Sex of Flowers. By W. Watson, F.R.S.

The sex of plants is very well confirmed by an experiment which has been made on the palma major foliis flabelliformibus. There is a great tree of this kind in the garden of the Royal Academy at Berlin. It has flowered and born fruit these 30 years; but the fruit never ripened, and when planted, it did not vegetate. The palm-tree is a planta dioecia; that is, one of those in which the male and female parts of generation are on different plants. We having, therefore, no male plant, the flowers of our female were never impregnated by the farina of the male. There is a male plant of this kind in a garden at Leipsic, 20 German miles from Berlin. We procured from thence, in April, 1749, a branch of male flowers, and suspended it over our female ones, and our experiment succeeded so well, that our palm-tree produced more than 100 perfectly ripe fruit; from which we have already 11 young trees. This experiment was repeated last year, and our palm-tree bore above 2000 ripe fruit.'

The impregnation of the female palm-tree by the male has been known in the most ancient times. Herodotus, when speaking of the palm-tree, says, "that the Greeks call some of these trees male, the fruit of which they bind to the other kind, which bears dates; that the small flies, with which the male abounds, may assist in ripening the fruit; for," says this author, "the male palm-tree produces in its fruit small flies, just as the fig-tree does."

Theophrastus, in his account of the palm-tree, gives the very process mentioned by our correspondent. "They bring together," says he, "the males and the females, which causes the fruit to continue and ripen on the trees. Some, from the

similitude of this to what happens in fig-trees, call it caprification; and it is performed in the following manner: while the male plant is in flower, they cut off a branch of these flowers, and scatter the dust and down in it on the flowers of the female plant. By these means the female does not cast her fruit, but preserves them to maturity." Pliny mentions the like process. Among more modern authors, Prosper Alpinus relates the manner of the impregnation of the female palm-tree by the male, for the purposes before mentioned.

Some of the more skilful modern gardeners put in practice, with regard to melons and cucumbers, the very method mentioned by Theophrastus 2000 years ago, in regard to the palm-tree. As these plants, early in the season, are in this climate confined to frames and glasses, the air, in which they grow, is more stagnant than the open air, by which the distribution of the farina fœcundans, so necessary towards the production of the fruit for the propagation of the species, is much hindered; to obviate which, they collect the male flowers when fully blown, and presenting them to the female ones, by a stroke of the finger they scatter the farina fœcundans in them, which prevents the falling of the fruit immaturely.

Besides the vegetables before mentioned, which bear male and female flowers on the same root, there are others, which produce these organs on different roots: in the number of these are the palm-tree (the more particular subject of this paper), hops, the willow-tree, mistletoe, spinach, hemp, poplar, French and dog's mercury, the yew-tree, juniper, and several others. Among these, the valisneria of Linnæus, as to the manner in which its male flower impregnates the female, is one of the most singular prodigies in nature.

The foundation of the discovery of the real sex of plants, which is of no less importance in natural history than that of the circulation of the blood in the animal economy, was laid by the members of the Royal Society; though much of the honour due to them is attributed by foreigners to the late ingenious Mons. Vaillant of Paris; and this may have arisen from our language not being generally understood on the Continent.

Concerning Mr. Bright, the Fat Man at Malden, in Essex. By T. Cole, M.D.

Mr. Edward Bright, grocer, of Malden, in Essex, died there the 10th of November, 1750, in the 30th year of his age. He was a man so extremely fat, and of such an uncommon bulk and weight, that there are very few, if any, such in-

stances to be found in any country, or on record in any books. He was descended from families greatly inclined to corpulency, both on his father's and his mother's side. He was always fat from a child, yet strong and active, and used much exercise, not only when a boy, but till within the last two or three years of his life, when he became too unwieldy. He could walk nimbly, having great strength of muscles, and could not only ride on horseback, but would sometimes gallop after he became between 30 and 40 stone weight. He used to go to London about his business, till the journey (40 miles) became too great a fatigue to him; so that he left it off some years before he died. In the last year or two he could walk but a little way, being soon tired, and out of breath. At 12½ years old he weighed 144 pounds; and before he was 20 he weighed 24 stone or 336 pounds. The last time he was weighed, about 13 months before he died, his weight, exclusive of his clothes, was 41 stone and ten pounds, or 584 pounds. What it exactly was at the time of his death cannot be told; but as it was manifestly increased since the last weighing, if we take the same proportion by which it had increased for many years on an average; viz. about two stone a year, and only allow four pounds addition for the last year, on account of his moving about but little, while he continued to eat and drink as before, this will bring him to 44 stone, or 616 pounds.

As to his measure, he was five feet nine inches and a half high. His body round the chest just under the arms measured five feet six inches, and round the belly six feet 11 inches. His arm in the middle of it was two feet two inches about, and his leg two feet eight inches. When a youth he used to eat somewhat remarkably; but toward the end of his life, though he continued to eat heartily, and with a good relish, yet he did not eat more in quantity than many other men of good appetite. Though he did not take any liquor to an intoxicating degree, yet, perhaps, on the whole, he drank more than might have been advisable to a man of his very corpulent disposition. When he was a very young man, he was fond of ale and old strong beer; but afterwards his chief liquor was small beer, of which he commonly drank about a gallon in a day. In other liquors he was extremely moderate, when by himself, sometimes drinking half a pint of wine after dinner, or a little punch, and seldom exceeding his quantity; but when he was in company, he did not confine himself to so small an allowance.

He enjoyed for the most part as good health as any man, except that in the last three years, he was two or three times

seized with an inflammation in his leg, attended with a little fever; and every time with such a tendency to mortification, as to make it necessary to scarify the part. But by the help of scarifications and fomentations, bleeding largely once or twice in the arm, and purging, he was always soon relieved.

He married when 22 or 23 years old, and lived a little more than seven years in that state; in which time he had five children born.

His last illness, which continued about fourteen days, was a miliary fever. It began with pretty strong inflammatory symptoms, a very troublesome cough, great difficulty of breathing, &c. and the eruption was extremely violent. His body began to putrefy very soon after he was dead; so that, notwithstanding the weather was cool, it became very offensive the next day, before a coffin could be made. The coffin was three feet six inches broad at the shoulders, two feet three inches and a half at the head, 22 inches at the feet, and three feet one inch and a half deep.

On the Phenomena of Electricity in Vacuo. By Mr. WILLIAM WATSON.

FROM a comparison of experiments in electricity made in vacuo, with those already made in open air, it appears, that on the removal of the air the electricity pervades the vacuum to a considerable distance, and manifests its effects on any non-electric substances, which terminate that vacuum; and that by these means, originally-electric bodies, even in their most perfect state, put on the appearance of non-electrics, by becoming themselves the conductors of electricity.

The experiments alluded to in this paper must be considered to have been made in a vacuum by Mr. Smeaton's air-pump, that rarefies 1000 times.

It appeared from them, that the electricity, meeting with scarcely any resistance, passed from the top to the bottom, and electrized the air-pump; and it was a most delightful spectacle, when the room was darkened, to see the electricity in its passage; to be able to observe, not, as in the open air, its brushes or pencils of rays an inch or two in length, but here the coruscations were of the whole length of the tube between the plates, viz. 32 inches, and of a bright silver hue. These did not immediately diverge as in the open air, but frequently, from a base apparently flat, divided themselves into less and less ramifications, and resembled very much the most lively coruscations of the aurora borealis.

Hence it appears that our atmosphere, when dry, is the agent by which we are enabled to accumulate electricity on non-electrics; as in the experiment before us, on the removal of it, the electricity passed off into the floor through a vacuum, of the greatest length we have hitherto been able to make, became visible in this vacuum, and manifested itself by its effects on the air-pump, being the non-electric substance, which terminated that vacuum; whereas, when the air is not taken away, the dissipation of the electricity is from every part of the prime conductor. We see, also, contrary to what we have found hitherto, that an originally-electric body, viz. a dry glass tube, puts on the appearance of a non-electric, by becoming itself the conductor of electricity, that is, by its keeping out the air, and suffering the electricity to pervade the vacuum.

Mr. W. was desirous of knowing, for the further illustration of his propositions, whether the Leyden experiment could be made through the vacuum. For this purpose he made the before-mentioned exhausted tube part of the circuit, so necessary to this experiment. In this experiment it is absolutely necessary that the whole quantity, or nearly so, of the accumulated electricity, should be discharged in the same instant of time. Accordingly, on making the experiment, at the instant of the explosion a mass of very bright embodied fire was seen to dart from one of the brass plates in the tube to the other; but this did not take place when one of the plates was farther distant from the other than 10 inches. When the distance was greater, the fire then began to diverge, and lose part of its force; and this force diminished in proportion to its divergency, which was nearly as the distance of the two plates.

On Coral. By the Sieur de PEYSSONNEL*, M.D.*

M. DE PEYSSONNEL, in relation to the question, whether coral is a plant, according to the general opinion, or a petrification or congelation, according to some, after exhibiting the various arguments delivered in support of these, concludes that coral, as well as all other stony sea-plants, and even sponges, are the work of different insects, particular to each species of these marine bodies, which labour uniformly according to their nature, and as the Supreme Being has ordered and determined. The coral-insect [worm], which is here called a little urtica, purpura, or polype, and which Marsigli took for its flower, expands itself in water, and

contracts itself in air, or when you touch it in water with your hand, or pour acid liquors to it. This is usual to fishes or insects of the vermicular kind.

When our author was upon the coast of Barbary in 1725, he had the pleasure of seeing the coral-insect move its claws or legs; and having placed a vessel of sea-water with coral therein near the fire, these little insects expanded themselves. He increased the fire, and made the water boil, and by these means kept them in their expanded state out of the coral, as happens in boiling shell-animals, whether of land or sea. Repeating his observations on other branches, he clearly saw that the little holes perceptible on the bark of the coral were the openings through which these insects went forth. These holes correspond with those little cavities or cells which are partly in the bark, and partly on the substance of the coral; and these cavities are the niches which the insects inhabit. In the tubes, which he had perceived, are contained the organs of the animal; the glandules are the extremities of its feet, and the whole contains the liquor or milk of coral, which is the blood and juices of the animal. When he pressed this little elevation with his nails, the intestines and whole body of the insect came out mixed together, and resembled the thick juice furnished by the sebaceous glands of the skin. He saw that the animal, when it wanted to come forth from its niche, forced the sphincter at its entrance, and gave it an appearance like a star with white, yellow, or red rays. When the insect comes out of its hole without expanding itself, the feet and body of it form the white appearance observed by Marsigli; but being come forth, and expanded, it forms what that gentleman and our author took for the petals of the flowers of coral, the calyx of this supposed flower being the body of the animal protruded from its cell. The milk before mentioned is the blood and natural juice of the insect, and is more or less abundant in proportion to its health and vigour.

On the coast of Barbary, the fishermen brought him, in a barrel of sea-water, one of those madreporas which are called in Provence fenouille de mer, or sea-fennel. It had been put into the barrel as soon as it was taken out of the sea; and he observed, that the extremities of this madrepora were soft and tender, furnished with a transparent mucosity, like that of snails: these extremities were of a beautiful yellow colour, and were five or six lines in diameter. In this he saw an animal, resembling the cuttle-fish, polype, or sea-nettle. The body of this fish filled the centre: its head was placed in the middle of it, and was surrounded by several

feet or claws: these feet filled the intervals of the partitions observed in the madrepora, and were at pleasure brought to its head, and were furnished with yellow papillæ. Its head or centre was lifted up occasionally above the surface, and often contracted and dilated itself like the pupil of the eye. He had the pleasure of seeing it move distinctly all its claws, as well as its head or centre.

The flesh of the animal of the madrepora is so soft, that it divides on the gentlest touch. This soft texture prevented M. de P. from detaching any one; and he observes that there are in those seas several large species of urtica, which become soft on the least touch. He mentions one sort of above a foot in diameter, whose body is as large as a man's head, and which is of a poisonous nature. After the madrepora had been preserved three days, the contained animals covered its whole surface with a transparent jelly, which melted away, and fell to the bottom of the water as the animal died: and both the water and madrepora then had a putrid fishy smell. After having destroyed and consumed all the animals, the extremities of the madrepora became white.

From what has been extracted, concerning the coral and madrepora, an idea may be formed of the millepora, lythophyton, corallines, and sponges; each of which is, according to our author, the habitation of numerous animals. and formed by them. He has given, from his own observations, particular accounts of each of these productions, and divided them into genera and species with great accuracy; and though in common they are the habitations of animals, each species varying in form and bulk, and composing its cell in various forms and manners, and of different consistences, constitutes their essential character. As oysters, scallops, muscles, cockles, snails, &c. have a power given them, by the Author of nature, of forming and enlarging their separate dwellings, to these bodies, the subjects of this treatise, the same power is given, but in large families. In the madrepora, its animal occupies the extremity; in the millepora, the substance; in corallines and sponges, the void places; in coral and lithophytes, the cortical parts. Each of these animals, according to their kind, furnish substances differing as much in consistence as in form. That of coral is extremely hard, and compact; the madrepora and millepora are of a stony, but more loose texture; the coralline is still more soft; the lithophyton, of a substance nearer horn than stone; and the sponge is soft and elastic.

Letters of the Abbé Mazeas, F.R.S., on the Success of the late Experiments in France, concerning the Analogy of Thunder and Electricity.

The Philadelphian experiments which Mr. Collinson communicated to the public having been univerally admired in France, the King desired to see them performed. Therefore the Duke d'Ayen offered his Majesty his country-house at St. Germain, where M. de Lor, master of experimental philosophy, should put those of Philadelphia in execution. His Majesty saw them with great satisfaction, and greatly applauded Messieurs Franklin and Collinson. These applauses of his Majesty having excited in Messieurs de Buffon, D'Alibard, and De Lor, a desire of verifying the conjectures of Mr. Franklin, on the analogy of thunder and electricity, they prepared themselves for making the experiments.

M. d'Alibard chose for this purpose a garden situated at Marly, where he placed on an electrical body a pointed bar of iron, of 40 feet high. On the 10th of May, 20 minutes past two, afternoon, a stormy cloud having passed over the place where the bar stood, those that were appointed to observe it drew near, and attracted from it sparks of fire, perceiving the same kind of commotions as in the common electrical experiments. M. de Lor, sensible of the good success of this experiment, resolved to repeat it at his house in the Estrapade at Paris. He raised a bar of iron 99 feet high, placed on a cake of resin, two feet square, and three inches thick. On the 18th of May, between four and five in the afternoon, a stormy cloud having passed over the bar, where it remained half an hour, he drew sparks from the bar. These sparks were like those of a gun, when, in the electrical experiments, the globe is only rubbed by the cushion, and they produced the same noise, the same fire, and the same crackling. They drew the strongest sparks at the distance of nine lines, while the rain, mingled with a little hail, fell from the cloud, without either thunder or lightning; this cloud being, according to all appearance, only the consequence of a storm, which happened elsewhere. From this experiment they conjectured, that a bar of iron, placed in a high situation on an electrical body, might attract the storm, and deprive the cloud of all its thunder.

St. Germain, July 12. 1752.—Towards 11 in the morning the heavens began to be covered to the south-west, with some claps of thunder and lightning at a great distance. The had just time to go to the garden, where he found the

Duke d'Ayen, who had prepared every thing for the experiments. An iron wire descended from the top of the pole, and rested on the hot-house of the garden: this wire was supported by a silken cord, and was terminated by a tin cylinder, of about three inches diameter, and three feet long. The electricity of this cylinder was such that, when a finger approached it, two or three very lively sparks at a time were produced, with a noise like that of the nails of one's fingers cracked against each other. Then the Duke d'Ayen took the first shrub he met in the hot-house, which happened to be that from which the labdanum is produced: he placed it with its pot on a cake of resin, and fastened the iron wire to one of its branches. This shrub was instantly electrified, so that whitish sparks issued from every leaf, with the same kind of cracking just mentioned; but the trunk of this shrub had a much stronger electricity; whether at that instant the electricity of the cloud was more strong (for it varies every moment), or that the force of the whole electricity, expanded through the leaves, became concentrated in the trunk of this shrub. The Duke then took one of his silver watering-pots, which was two feet and a half high: he filled it with water within an inch of the brim, and placed it on the electrical cake, dipping into it a wire of lead, which communicated with that wire which came from the top of the pole. Of all the electricity tried till then, this was incomparably the strongest: there were 20 sparks; and on advancing the finger towards it, the shock affected the arms and breast with great violence.

Letter from BENJAMIN FRANKLIN, *Esq. concerning an Electrical Kite. Dated Philadelphia, October* 1. 1752.

As frequent mention is made in the public papers from Europe, of the success of the Philadelphia experiment, for drawing the electric fire from clouds by means of pointed rods of iron erected on high buildings, &c. it may be agreeable to the curious to be informed, that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner, which any one may try, as follows: —

Make a small cross, of two light strips of cedar; the arms so long, as to reach to the four corners of a large thin silk handkerchief, when extended: tie the corners of the handkerchief to the extremities of the cross: so you have the body of a kite; which being properly accommodated with a tail, loop, and string, will rise in the air like those made of paper; but this, being of silk, is fitter to bear the wet and

wind of a thunder-gust without tearing. To the top of the upright stick of the cross is to be fixed a very sharp-pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon; and where the twine and silk join, a key may be fastened.

The kite is to be raised when a thunder-gust appears to be coming on, and the person who holds the string must stand within a door, or window, or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine does not touch the frame of the door or window. As soon as any of the thunder clouds come over the kite, the pointed wire will draw the electric fire from them; and the kite, with all the twine, will be electrified; and the loose filaments of the twine will stand out every way, and be attracted by an approaching finger.

When the rain has wet the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle. At this key the phial may be charged; and from electric fire thus obtained spirits may be kindled, and all the other electrical experiments be performed, which are usually done by the help of a rubbed glass globe or tube. and thus the sameness of the electric matter with that of lightning is completely demonstrated.

Of the great Alterations which the Islands of Scilly have undergone since the Time of the Ancients. By the Rev. Mr. William Borlase.

The inhabitants of these isles are all new-comers; there is not here an old habitation worth notice; nor any remains of Phenician, Grecian, or Roman art, either in town, castle, port, temple, or sepulchre. All the antiquities are of the rudest Druid times; and, if borrowed in any measure from those eastern traders before mentioned, were borrowed from their most ancient and simple rites.

How came these ancient inhabitants, then, it may be asked, to vanish, so as that the present have no pretensions to any affinity or connection of any kind with them, either in blood, language, or customs? How came they to disappear, and leave so few traces of trade, riches, or arts, and no posterity, that we can learn, behind them? Two causes of this fact occurred while Mr. B. was at Scilly, which may perhaps satisfy these enquiries;— the manifest encroachments of the sea, and as manifest a subsidence of some parts of the land.

The sea is the insatiable monster, which devours these ttle islands, gorges itself with the earth, sand, clay, and all he yielding parts, and leaves nothing, where it can reach, but the skeleton, the bared rock. The continual advances which the sea makes on the low lands are obvious, and within the last 30 years have been very considerable. What we see happening every day may assure us of what has happened in former times; and from the banks of sand and earth giving way to the sea, and the breaches becoming still more open, and irrecoverable, it appears that repeated tempests have occasioned a gradual dissolution of the solids for many ages, and as gradual progressive ascendency of the fluids.

On shifting of the sands in the channel, walls and ruins are frequently seen: there are several phenomena of the same nature, and owing to the same cause, to be seen on these shores. Here, then, we have the foundations, which were probably six feet above high-water mark, now 10 feet under, which together make a difference as to the level of 16 feet. To account for this, the slow advances and depredations of the sea will by no means suffice; we must either allow, that the lands inclosed by these fences have sunk so much lower than they were before, or else we must allow, that since these lands were inclosed, the whole ocean has been raised 16 feet perpendicular; which last will appear much the harder and less tenable supposition of the two. Here then was a great subsidence; the land between Sampson and Trescaw sunk at least 16 feet, at a moderate computation. This subsidence must have been followed by a sudden inundation, and this inundation is likely not only to have destroyed a great part of the inhabitants, but to have terrified others who survived into a total desertion of their shattered islands. By this means, as I imagine, that considerable people, who were the aborigines, and carried on the tin trade with the Phœnicians, Greeks, and Romans, were extirpated.

Tradition seems to confirm this; there being a strong persuation in the western parts of Cornwall, that formerly there existed a large country between the Land's End and Scilly, now laid many fathoms under water. The particular arguments by which they support this tradition may be seen in Mr. Carew's Survey of Cornwall, and in the last edition of Camden.

But though there are no evidences to be depended on, of any ancient connection of the Land's End and Scilly, yet that the cause of that inundation, which destroyed much of these islands, might reach also to the Cornish shores is extremely

probable, there being several evidences of a like subsidence of the land in Mount's Bay.

Account of the Death of Mr. George William Richman, Professor of Experimental Philosophy, and a Member of the Imperial Academy of Sciences at Petersburgh.

In order to demonstrate what Mr. R. might advance in an intended discourse on electricity with the greater certainty, he neglected no opportunity, on the appearance of a thunder-cloud, diligently to discover its strength. Bars were standing for this purpose always on the roof of the house. These received the electrical power of the clouds, and imparted it to certain chains fastened to them; by which it was conducted into one of his rooms, where his apparatus was. He was attending the usual meeting of the Academy the 26th of July, 1753, a little before noon, when it thundered at a pretty distance, the sky being clear, and the sun shining. On this he hastened home, in hopes of confirming his former observations, or possibly enabling himself to make new ones.

The engraver Sokolow, who had the care of his treatise, accompanied him, to make himself the better acquainted with the chief circumstances of the electrical experiment, in order to be enabled to represent it more justly on a copper-plate. Mr. Richman carried the engraver immediately to his apparatus, taking notice of the degree of electricity on his bar, which was then only four; and by which it appeared that his bar had received very little from the thunder. He described to Mr. Sokolow the dangerous consequences which would attend the electrical power being increased to the 45th, or more degrees of his expositor.

In the mean time the misfortune happened, about half an hour after noon, which cost Professor Richman his life. A thick cloud, that came from the north-east, and seemed to float very low in the air, was taken notice of by people walking in the street; and these affirm, that they could plainly see, on the subsequent flash of lightning, and peal of thunder, a quantity of vaporous matter issue from it, which diffused itself in the circumjacent space.

According to the account of the engraver Sokolow, Mr. Richman inclined his head towards the expositor, to observe what degree of force it would have; and while he stood in that bent posture, a great white and bluish fire app[eared] between the electrical expositor and Mr. Richman's [head]. At the same time arose a sort of stream, or vapour, whi[ch]

entirely benumbed the engraver, and made him sink down on the ground; so that he cannot remember to have heard the loud thunder-clap.

The particulars, which happened to Mr. Richman, Mr. Sokolow is ignorant of. As soon as he had recovered his senses, he got up, and ran out of the house, acquainting every one whom he met in the street, that the thunder had struck into into Mr. Richman's house. On the other side, as soon as Mrs. Richman heard the very loud stroke of thunder, she came hastening into the chamber, in which she conjectured she should see the bad consequences. She found her husband past sensation, sitting upon a chest, which happened to be placed behind him, and leaning against the wall; which situation must have been occasioned by his falling back on receiving the electrical blow. He was no sooner struck than killed. There was not the least appearance of life. A sulphureous smell, not unlike that which is caused by the explosion of gunpowder, diffused itself through the whole house. Some servants, who were hard by in the kitchen, felt its effects, being quite stupified The electrical expositor stood on a low buffet, upon which was likewise placed a China bowl that was cracked; and there was such a shaking in the house, that the shock even stopped the movement of an English clock, or pendulum, which was in an adjoining room. No other consequences were observed in the house. But we have found another effect of the force of electricity, or of thunderbolts, discoverable by the door-posts of the house; for they were rent asunder lengthwise, and the door, with that part of the posts, so torn away, twirled into the porch. The reason of which appears to be, because one of the above-mentioned chains, that were carried from the bars at the house-top to the expositor, passed very near them; and the kitchen-door, being at a little distance off, had a splinter torn out and dashed against a staircase, that went towards the top of the house; so that part of the electrical matter seems to have taken its course this way, but without doing any more damage. They opened a vein of the breathless body twice, but no blood followed. They endeavoured to recover sensation by violent chafing, but in vain. On turning the corpse topsy-turvy, during the rubbing, an inconsiderable quantity of blood fell out of the mouth. There appeared a red spot on the forehead, from which spirted some drops of blood through the pores, without wounding the skin. The shoe belonging to the left foot was burst open. Uncovering the foot at that place, they found a blue mark, by which it is concluded, that

the electrical force of the thunder having passed into the head, made its way out again at the foot. On the body, particularly on the left side, were several red and blue spots, resembling leather shrunk by being burnt. Many more blue spots were afterwards visible over the whole body, and in particular on the back. That on the forehead changed to a brownish red. The hair of the head was not singed, though the spot touched some of it. In the place where the shoe was unripped, the stocking was entire; as was his coat every where, the waistcoat being only singed on the fore flap, where it joined the hinder. But there appeared on the back of the engraver's coat long narrow streaks, as if red-hot wires had burnt off the nap.

On the Books and Ancient Writings dug out of the Ruins of an Edifice near the Site of the old City of Herculaneum.

Within two years last past, in a chamber of a house, or more properly speaking, of an ancient villa, in the middle of a garden, has been found a great quantity of rolls, about a palm long, and round; which appeared like roots of wood, all black, and seeming to be only of one piece. One of them falling on the ground, it broke in the middle, and many letters were observed, by which it was first known, that the rolls were of papyrus. The number of these rolls were about 150, of different sizes. They were in wooden cases, which are so much burnt, as are all the things made of wood, that they cannot be recovered. The rolls, however, are hard, though each appears like one piece. The King has caused infinite pains to be taken to unroll them, and read them; but all attempts were in vain; only by slitting some of them some words were observed.

At length Sig. Assemani, being come a second time to Naples, proposed to the King to send for one Father Antonio, a writer at the Vatican, as the only man in the world who could undertake this difficult affair. It is incredible to imagine what this man contrived and executed. He made a machine, with which, by the means of certain threads, which being gummed, stuck to the back part of the papyrus, where there was no writing, he begins, by degrees, to pull, while with a sort of engraver's instrument he loosens one leaf from the other, which is the most difficult part of all, and then makes a sort of lining to the back of the papyrus, with exceedingly thin leaves of onion, if I mistake not, and with some spirituous liquor, with which he wets the papyrus, by

little and little as he unfolds it. All this labour cannot be well comprehended without seeing it. With patience superior to what a man can imagine, this good father has unrolled a pretty large piece of papyrus, the worst preserved, by way of trial.

It is found to be the work of a Greek writer, and is a small philosophic tract, in Plutarch's manner, on music; blaming it as pernicious to society, and productive of softness and effeminacy. It does not discourse of the art of music. The beginning is wanting, but it is to be hoped, that the author's name may be found at the end; it seems, however, to be the work of a Stoic philosopher; because Zeno is much commended. The papyrus is written across in so many columns, every one of about 20 lines, and every line is the third of a palm long. Between column and column is a void space of more than an inch. There are now unrolled about 30 columns; which is about a half of the whole; this roll being one of the smallest; the letters are distinguishable enough. Father Antonio, after he has loosened a piece, takes it off where there are no letters; and places it between two crystals for the better observation; and then, having an admirable talent in imitating characters, he copies it with all the lacunæ, which are very numerous in this scorched papyrus, and gives this copy to the Canon Mazzocchi, who tries to supply the loss, and explain it. The letters are capital ones, and almost without any abbreviation. The worst is, the work takes up so much time, that a small quantity of writing requires five or six days to unroll, so that a whole year is already consumed about half this roll. The lacunæ, for the most part, are of one or two words, that may be supplied by the context. As soon as this roll is finished, they will begin a Latin one. There are some so voluminous, and the papyrus so fine, that unrolled they would take up 100 palms' space.

An extraordinary and surprising Agitation of the Waters, though without any perceptible Motion of the Earth, having been observed in various Parts of this Island, both Maritime and Inland, on the same Day, and chiefly about the Time that the Earthquake took place at Lisbon, the following Accounts were transmitted to the Society.

At Portsmouth, in Hampshire. By Mr. JOHN ROBERTSON, *F.R.S.* — On Saturday, Nov. 1. 1755, about 35 minutes after 10 in the morning, there was observed in the dock-yard

at Portsmouth an extraordinary motion of the waters on the north dock, and in the basin, and at two of the jetty-heads. In the north dock, whose length is about 229 feet, breadth 74 feet, and at that time about 17½ feet depth of water, shut in by a pair of strong gates, well secured, his Majesty's ship the Gosport of 40 guns was just let in to be docked, and well stayed by guys and hawsers. On a sudden the ship ran backwards near three feet, and then forwards as much, and at the same time she alternately pitched with her stern and head to the depth of near three feet; and by the libration of the water the gates alternately opened and shut, receding from each other near four inches.

In Sussex. By PHILIP CARTERET WEBB, *Esq. F. R. S.*— In his garden at Busbridge, near Godalmin, in Surrey, on Saturday the first of November, 1755, at half an hour after 10 in the forenoon, Philip Smith, John Street, and John Johnson, the gardeners, were alarmed by a very unusual noise in the water, at the east end of the long canal, near which John Street and John Johnson were then at work. On looking that way, they observed the water, in that part of the canal, in great agitation, attended with a considerable noise. The water soon raised itself in a heap or ridge, extending lengthwise about 30 yards, and between two and three feet above the usual level of the water; after which the heap or ridge heeled or vibrated towards the north, or left side of the canal, with great force, and flowed about eight feet over the grass-walk on that side of the canal, quite up to the arch. On the water's returning back into the canal, it again raised itself into a heap or ridge in the middle; after which the heap or ridge heeled or vibrated with greater force towards the south, or right-hand side of the canal, and flowed over the grass-walk, and through the rustic arch on that side; and drove a small stream of water, which runs through it, 36 feet back upwards, towards its source. During this latter motion, the bottom of the canal, on the north side, for several feet in width, was quite bare of water. The water being returned into the canal, the vibrations became less and less, but so strong, as to make the water flow several times over the south bank of the canal, which is not so high as the north bank. In about a quarter of an hour from the first appearance the water became quiet and smooth as before.

Mr. W. was informed, that the water was affected about the same time in the following places: In a mill-pond, at Medhurst, in Sussex, the sudden agitation and swell of the water rolling toward the mill was so remarkable, that the miller

imagined a sluice had been opened at the upper end of the pond, and had let a back-water into it; but on search it was found to be shut as usual. Below the mill the swell of the water was so great, as to drive the stream upwards, back into the conduit of the mill. At Lee, in the parish of Whitley, in Surrey, about five miles from Busbridge, between Busbridge and Medhurst, the water in a canal or pond belonging to Mr. Luff was so violently agitated, that the gardener, on the first appearance, ran for help, thinking a number of otters were under the water, destroying the fish. In a mill-pond, near Guildford, in Surrey, a like swell and agitation of the water was observed by several persons, one of whom stood all the time on a bridge of wood, over the pond. Not the least tremor or motion of the earth was felt in any of these places, or at the bridge at Guildford.

At Cranbrook, in Kent. By WM. TEMPEST, *Esq. F.R.S.*— The people here are very much alarmed on account of an earthquake, which happened last Saturday (November the 1st). I felt nothing of it, but some people fancied they did. I do not hear that the earth moved; only the waters of several ponds, in this and the adjacent parishes, were in such motion, that they overflowed their banks, then returned back, and overflowed the other side.

Near Tunbridge. By JOHN PRINGLE, *M.D. F.R.S.*— The pond at Eaton Bridge, near Tunbridge, is about an acre in size, and across it is a post and rail, which is almost covered by the water. Some people heard a noise in the water, and imagining something had tumbled in, ran to see what was the matter; when, to their surprise, they saw the water open in the middle, so that they could see the post and rail a long way down, almost to the bottom, and the water dashing up over a bank about two feet high, and perpendicular to the pond. This it did several times, making a great noise. They did not feel the least motion on the shore, nor was there any wind, but a dead calm.

In Peerless Pool, near Old Street, London. By THOMAS BIRCH, *D.D.*—On the reports, received from several gentlemen, that the agitation of the waters observed in many parts of England, Scotland, Ireland, Holland, &c. on Saturday Nov. 1. 1755, had been likewise noticed in Peerless Pool, near Old Street Road. Dr. B. went thither on Saturday, Dec. 6. 1755, and took down the following particulars relating to it, from an eye-witness. Between 10 and 11 in the morning, accidentally casting his eye on the water, he was surprised to see it greatly moved without the least apparent cause, as the

air was quite calm. This occasioned him to call to his companion to take notice of it, who at first neglected it, till being urged to attend to so extraordinary an appearance, he was equally struck with the sight of it. Large waves rolled slowly to and from the bank near them, at the east end, for some time, and at last left the bed of the pond dry for several feet, and in their reflux overflowed the bank 10 or 12 feet, as they did the opposite one, which was evident from the wetness of the ground about it.

In Berkshire, near Reading. By Mr. RICHARD PHILIPS.—On the 1st of November last, at about 11 o'clock in the morning, as Mr. Pauncefort's gardener was standing by a fish-pond in the garden, he felt a most violent trembling of the earth, directly under his feet, which lasted upwards of 50 seconds; immediately after which he observed that the water in the pond was in a very unusual motion, and suddenly thrown on the opposite side, leaving that on which he stood quite dry, for the space of two yards, and continued in that state for about two minutes, when it returned as before, and collecting in or near the middle of the pond, rose about 20 inches above the level of the water on each side, and continued so for two minutes in violent agitation, which the gardener described to be like the boiling of a pot.

At the same time Captain Clarke, at Caversham, in Oxfordshire, a mile distant from Reading, was alarmed with a very great noise, as if part of the house had been falling down; on examination, however, it did not appear that the house was at all damaged; but a vine, which grew against it, was broken off, and two dwarf-trees, such as are used in espalier hedges, were split by the shock.

In Oxfordshire, at Shirburn Castle. By Lord Viscount PARKER.—On Saturday, November 1. a little after 10 o'clock in the forenoon, walking in the garden at Shirburn Castle, he perceived the gardener, who was coming towards him by the end of the moat, on a sudden stop short, and look earnestly into the water. He went towards him, and perceived immediately a very strange motion in the water. There was a pretty thick fog, not a breath of air, and the surface of the water all over the moat was as smooth as a looking-glass; yet in that corner of the moat near which he stood the water flowed into the shore, and retired again successively, in a surprising manner. The flux and reflux were quite regular. Every flood began gently: its velocity increased by degrees, till at last, with great impetuosity, it rushed in till it had reached its full height, at which it remained for a little while, and then again retired, at

first gently ebbing, at last sinking away with such quickness, that it left a considerable quantity of water entangled among the pebbles, laid to defend the bank, which run thence in little streams over the shore, now deserted by the water, which at other times always covers it.

In Devonshire and Cornwal, at Plymouth, &c. *By* JOHN HUXHAM, *M.D. F.R.S.*—Saturday, November 1., about four P.M., we had (just about high water) an extraordinary boar, as the sailors call it. The sea seemed disturbed about 20 minutes before, though there was very little wind that day, or for some days before. One of our surgeons, who had then just crossed the ferry at Creston, a mile to the south-east of Plymouth, said, that the tide had made a very extraordinary out (or recess), almost immediately after high water (about four P. M.), and left both the passage-boats, with some horses, at once quite dry in the mud, though they had been, a minute or two before, in four or five feet water; in less than eight minutes the tide returned with the utmost rapidity, and floated both the boats again, so that they had near six feet water. The sea sunk and swelled, though in a much less degree, for near half an hour longer. It was said, that at the next morning's tide there were several very large surges. This boar drove several ships from their moorings, and broke some of the hawsers, and twirled the ships and vessels round in a very odd manner.

On the Coast of Cornwal. *By the Rev.* WILLIAM BORLASE.—A little after two o'clock in the afternoon, about half an hour after ebb, the sea was observed at the Mounts' Bay pier to advance suddenly from the eastward. It continued to swell and rise for the space of 10 minutes; it then began to retire, running to the west and south-west, with a rapidity equal to that of a mill-stream descending to an undershot-wheel; it ran so for about 10 minutes, till the water was six feet lower than when it began to retire. The sea then began to return, and in 10 minutes it was at the before mentioned extraordinary height; in ten minutes more it was sunk as before; and so it continued alternately to rise and fall between five and six feet, in the same space of time. The first and second fluxes and refluxes were not so violent at the Mount Pier as the third and fourth, when the sea was rapid beyond expression, and the alternations continued in their full fury for two hours; they then grew fainter gradually, and the whole commotion ceased about low water, $5\frac{1}{2}$ hours after it began.

Many other similar accounts were also given, as observed both in the sea and inland lakes: as at Swansea; on the

coasts of Norfolk and Lincolnshire, &c.; the lakes in Cumberland; a pond near Durham, at half past 10 o'clock; at Loch Ness, Loch Lomond, &c. in the north of Scotland, about 10 o'clock.

It appears, also, by communications sent from abroad, that the like agitations of the water were observed at the Hague, Leyden, Haerlem, Amsterdam, Utrecht, Gouda, and Rotterdam, and also at Bois-le-Duc, about 11 o'clock on the 1st of November; and likewise at Kingsale and Cork, in Ireland, between two and three o'clock.

Of an extraordinary Alteration in the Baths of Toplitz, in Bohemia, on the 1st of November, 1755. — On the 1st of November, 1755, between 11 and 12 in the morning, the chief spring cast forth such a quantity of water, that in the space of half an hour all the baths ran over. About half an hour before this vast increase of the water, the spring became turbid, and flowed muddy; and, having stopped entirely near a minute, broke forth again with prodigious violence, driving before it a considerable quantity of a reddish ochre, crocus martialis. After which it became clear, and flowed as pure as before, and continues still to do so; but it supplies more water than usual, and that hotter, and more impregnated with its medicinal quality.

The accounts brought from Norway inform us, that similar observations were made there, almost at the same time.

In the Lead Mines in Derbyshire. By the Rev. Mr. Bullock. — Two miners say, that on the morning of Nov. 1. they were employed in carting, or drawing along the drifts the ore and other minerals to be raised up the shafts. The drift where they were working is about 60 fathoms, or 120 yards deep, and the space of it from one end to the other upwards of 50 yards. They were suddenly surprised by a shock, which greatly terrified them. They durst not attempt to climb the shaft, lest that should be running in on them, but consulted what means to take for their safety. While they were thinking of some place of refuge, they were alarmed by a shock much more violent than the former; which put them in such a consternation, that they both ran precipitately to the other end of the drift. Soon after they were again alarmed by a third shock; which, after an interval of about four or five minutes, was succeeded by a fourth; and about the same space of time after, by a fifth; none of which were so violent as the second. They heard after every shock a loud rumbling in the bowels of the earth, which continued for about half a minute, gradually decreasing, or appearing at

a greater distance. They imagined, that the whole space of time, from the first shock to the last was about 20 minutes. They remained about 10 minutes in the mine after the last shock; when they thought it advisable to examine the passages, and to get out of the mine, if possible. As they went along the drifts, they observed, that several pieces of minerals had dropped from the sides and roof, but all the shafts remained entire, without the least discomposure.

Account of the Earthquake at Lisbon, Nov. 1. 1755.— On the first instant (Nov. 1755), about 40 minutes past nine in the morning, was felt a most violent shock of an earthquake: it seemed to last about the tenth part of a minute, and then came down every church and convent in the city, together with the King's palace and the magnificent opera-house adjoining it; in short, there was not a large building that escaped. Of the dwelling-houses, there might be about one fourth of them that fell, which, at a very moderate computation, occasioned the loss of thirty thousand lives.

The shocking sight of the dead bodies, with the shrieks and cries of those who were half buried in the ruins, are only known to those who were eye-witnesses. It far exceeds all description; for the fear and consternation was so great, that the most resolute person durst not stay a moment to remove a few stones off the friend he loved most, though many might have been saved by so doing; but nothing was thought of but self-preservation: getting into open places, and into the middle of streets, was the most probable security.

Such as were in the upper stories of houses were in general more fortunate than those that attempted to escape by the doors: for these were buried under the ruins with the greatest part of the foot-passengers: such as were in equipages escaped best, though their cattle and drivers suffered severely; but those lost in houses and the streets are very unequal in number to those that were buried in the ruins of churches; for as it was a day of great devotion, and the time of celebrating mass, all the churches in the city were vastly crowded, and the number of churches here exceeds that of both London and Westminster; and as the steeples are built high, they mostly fell with the roof of the church; and the stones are so large, that few escaped.

Had the misery ended here, it might, in some degree, have admitted of redress: for though lives could not be restored, yet the immense riches that were in the ruins might, in some part, have been digged out: but the hopes of this are almost gone, for in about two hours after the shock, fires broke out

in three different parts of the city, occasioned by the goods and the kitchen-fires being all jumbled together. About this time, also, the wind, from being perfectly calm, sprung up a fresh gale, which made the fire rage with such fury, that at the end of three days all the city was reduced to cinders.

Indeed every element seemed to conspire to our destruction; for soon after the shock, which was near high water, the tide rose 40 feet higher in an instant than was ever known, and as suddenly subsided. Had it not so done, the whole city must have been laid under water. As soon as we had time for recollection, nothing but death was present to our imaginations.

We are still in a state of the greatest uncertainty and confusion, for we have had in all 22 different shocks since the first, but none so violent as to bring any houses down in the outskirts of the town, that escaped the first shock; but nobody yet ventures to lie in houses; and though we are in general exposed to the open sky for want of materials to make tents, and though rain has fallen several nights past, yet the most delicate people suffer these difficulties with as little inconvenience as the most robust and healthy. Every thing is yet with us in the greatest confusion imaginable: we have neither clothes nor conveniences, nor money to send for them to other countries.

Two days after the first shock, orders were given to dig for the bodies, and a great many have been taken up and recovered. Our correspondent lodged in a house where there were 38 inhabitants, and only four saved. In the prison 800 were lost; 1200 in the general hospital; a great number of convents of 100 in each lost; the Spanish ambassador with 35 servants. The King and the royal family were at Belime, a palace about a league out of town. The palace in town fell in the first shock. The shock has been felt all over the kingdom, but along the sea-side more particularly. Faro, St. Ubals, and some of the large trading towns, are, if possible, in a worse situation than here; though the city of Porto has quite escaped.

It is possible, that the cause of all these misfortunes came from under the western ocean; for a captain of a ship, a very sensible man, said that he was 50 leagues off at sea; that the shock was there so violent as greatly to injure the deck of his ship; it occasioned him to think that he had mistaken his reckoning, and struck upon a rock, and they instantly hawled out their long-boat to save themselves; but happily brought the ship, though much injured, into this harbour.

The shocks lasted between five and seven minutes. The very first shock was extremely short, but then it was as quick as lightning, succeeded by two others, which, in the general way of speaking, are mentioned all together as only one shock. About 12 o'clock we had a second shock.

The day before the earthquake the atmosphere, and light of the sun, had the appearance of clouds and notable offuscation, and more strong and visible at the actual time of the great shock, which was by undulation, and lasted from six to eight minutes. It ruined not only this populous city, but all the southern part of the country of Estremadura, and a great part of the kingdom of Algarve. The earth opened in fissures in several parts, but neither fire nor visible smoke came out of it. The water in the sea rose several times, and in a few minutes made three fluxes and refluxes, rising above the greatest spring-tides about 15 English feet.

At Morocco, by the falling down of a great number of houses, many people lost their lives; and about eight leagues from this city, the earth opened, and swallowed up a village, with all the inhabitants (who were known by the name of the sons of Busumba), to the number of about 8000 or 10,000 persons, with their cattle of all sorts, as camels, horses, horned cattle, &c. and soon after the earth was closed again, in the same manner as it was before.

At Fez and Mequinez, on the 18th of November, there happened another earthquake, which was more violent than the first, and lasted till break of day on the 19th; during which time great numbers of houses fell at Fez: many people of both sexes were buried under their ruins; and as to Mequinez, there are but few houses left standing The people killed by the falling of the houses, besides the wounded, are numberless; and in the part of the town called the Jews' Habitation, only eight persons were saved.

The famous city of Tasso was wholly swallowed up; no remains were left.

Of the Earthquake felt at Boston, in New England, Nov. 18. 1755. By JOHN HYDE, *Esq. F.R.S.*—Tuesday, Nov. 18. 1755, about half an hour past four in the morning, Mr. H. was awakened by the shaking of his bed and the house; the cause of which he immediately concluded could be nothing but an earthquake, having experienced one before. The trembling continued about two minutes. Near 100 chimnies are levelled with the roofs of the houses: many more, probably not fewer than 1200 or 1500, are shattered, and thrown down in part; so that in some places, especially on the

low loose ground, made by encroachments on the harbour, the streets are almost covered with the bricks that have fallen.

Of the Earthquake felt in New York, Nov. 18. 1755. *By* CADWALLADER COLDEN, *Esq* — A few minutes past four in the morning, Mr. C. was awakened with the shock of the earthquake. He plainly heard the noise like that of carts on pavements, going to the eastward, with now and then a noise like the explosion of a great gun at a distance. It was felt about four o'clock at Philadelphia, and half past four at Boston, and was more violent to the eastward than the westward; and there was an eruption at a place called Scituate, about 20 or 30 miles to the southward of Boston.

Of the Earthquake felt in Pennsylvania, Nov. 18. 1755. — About four o'clock this province was pretty generally alarmed with the shock of an earthquake. It gradually increased for one minute to such a degree as to open the chamber-door, by drawing the bolt of the lock out of the staple. Some people thought they felt its continuance five or six minutes, but the writer thinks it did not exceed one, nor was it less.

On the Agitation of the Waters, Nov. 1. 1755, *in Scotland and at Hamburgh.* — About 10 o'clock of the forenoon of Nov. 1., a gentleman at Queen's Ferry, a sea-port town on the Frith of Forth, about seven miles higher up than Leith, observed the water rise very suddenly, and return again with the same motion, which he judged to be about 12 or 18 inches perpendicular, which made the barks and boats then afloat run forwards and backwards on their ropes with great rapidity; and this continued for three or four minutes, it being then calm; but after the second or third rush of water the agitation diminished.

The following phenomena are well vouched to have happened at Hamburgh, the 1st of November, 1755. In one of the churches many persons, that were present, observed an agitation of the branched candlesticks hanging from the roof, about one in the afternoon. In another church, the cover of the baptistery hanging from the roof was also remarked to be agitated; and the like motions are said to have happened in other churches. Also the water in the canal through the town, and in the river Alster, was agitated the same day. It is described, first to have formed several gentle whirlpools, then to have risen more and more impetuously; throwing about mud brought up from the bottom, and at last to have

subsided with a copious white froth. The Elbe rose in some places still more violently.

The Wonderful Configurations of the smallest shining Particles of Snow, with several Figures of them. By John Nettis, *M. D.*

The weather being intensely cold in the year 1740, the snow which fell was hard, entire, and pellucid, and some particles being received on a pencil, were placed on a plane glass plate under the object-glass of the best microscopes: the greatest care was taken that the smallest particles might not be dissolved, either by the breath or perspiration of the hands, lest the little angles might by the least degree of warmth disappear. And thus, with this apparatus and these precautions, the extreme exactness and equality of the figures of their most minute particles might be observed and delineated.

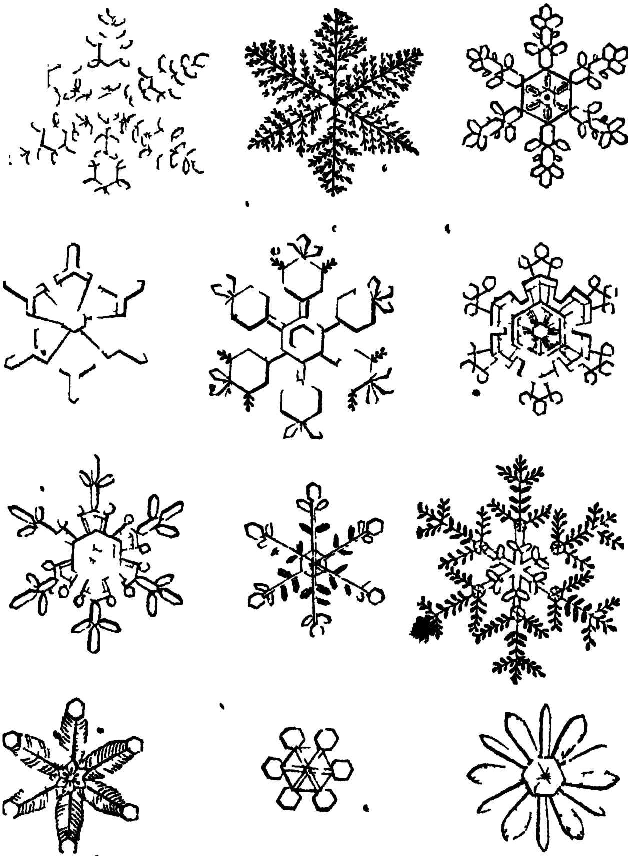
Some consisted of long round spiculæ; others approached to a round figure made up of small globules; but these were observed to be opaque, as the air was disposed to thaw; but when the air was frosty, many slender hexangular figures appeared, some of equal, others of unequal sides.

Several little stars seemed to consist of six oblong, round, hexangular lamellæ, or indeed of six rays terminating in points; which little stars appeared to be formed of six plane rhomboidal particles. Several plane hexangular particles of equal sides, or oblong hexangulars, adhered to several of these stars, either at their extremities, or at each side of every ray. Some hexangular lamellæ of equal sides were adorned all round with six other lamellæ of the same figure and size, or with hexangular oblong lamellæ, and to these sometimes adhered several others, more or less. Many of these hexangulars were ornamented with six rays, and to these were fixed the most slender lamellæ, which were also hexangular, of equal or unequal sides: but of equal angles of 60 degrees; and to these lamellæ others like them adhered, some greater and some less, but most of the latter; and various others, like the fortifications of cities, appeared to be joined to long hexangular spiculæ, and plane hexangles of equal sides.

And though a vast variety of these configurations of snow may fail or vanish in the same moment, yet the smaller particles, from their various combinations with each other, con-

stituting this wonderful variety of configurations of the snow, were observed by him to be comprehended under these following forms viz. of parallelograms, or oblong, straight, or oblique quadrangles, rhombs, rhomboids trapezia, or of hexangular forms of equal or unequal sides, whose angles are 60 degrees and these hexangular particles were far more numerous than those of any other form.

The natural size of most of the shining quadrangular par-



ticles, and of the little stars of snow, as well the simple as the less compound ones, does not exceed the twentieth part

of an inch; nor do the more compound particles the fifth of an inch.

Of the Fossil Shells called Orthoceratites. By EDWARD WRIGHT, M.D.

PELAGIAN or ocean shells are frequently found fossil very near the surface, as every naturalist knows; which proves, that such places have formerly been the sea-shore. The greatest depths of the sea, as yet sounded, have been found to be about 3000 fathoms, and the ordinary depths are about 150; which makes it evident, that such fossil shells ought never to be found at less depths in the earth than from 150 to 3000 fathoms.

Though fossil shells are to be found in almost all the lower parts of the surface of the earth, yet there are certain very large tracts, where such bodies are never found, viz. the mountains, which seem to be the remains of the original strata of the earth. In the Alps, Apennines, and Pyrenees, no shells nor marine bodies of any kind are to be found: in the Ochels, a branch of the large Grampian mountains in Scotland, which Dr. W. had occasion diligently to examine, he could discover no marine bodies. The same is observed of all the large mountains of Africa, and of Asia; and in the huge chain of Cordilleras in Perou, Mons. la Condamine searched in vain for such bodies. This kind of mountains, which indeed alone deserve that name, are chiefly composed of vitrifiable matter; and if they are sometimes found to contain sea-shells, it is never at great depths, nor in their original metallic or stony strata; though such bodies are found in great abundance at the foot of mountains, and in the adjacent vallies, in which there are many eminences in some parts continued in small chains, though but of little extent, which contain marble, sea-shells, chalk, and other calcinable matter, but never any veins of metal, though we frequently find in them pyrites, ochre, vitriols, and other minerals, which have been washed down from veins of iron and other metals, with which the higher mountains abound, and have afterwards been deposited in the calcareous strata of the vallies.

It is certain, that all our fossil shells are foreign to our climates, except such as are common to the whole globe. Besides, we find not only a very great quantity of fossil shells and other marine bodies, but also a great number of impressions of foreign plants, mostly of the capillary kind, on

slates and other stones; and it is now certain, that all the fossil wood of Loughneagh, in Ireland, (as in most other places where such wood is found) has been produced in a different climate. Bones, and even entire skeletons of rhinoceroses, elephants, and other foreign land animals, are discovered pretty commonly through all Europe. All these substances are commonly found near to, or in the same strata with, fossil shells, and other marine bodies; and all of them, whether original productions of sea or land, appear evidently to have been deposited in the places where we now find them.

There are many observations which seem to prove that the earth, or at least many parts of its surface, have suffered by fire; not to mention the marks of it observed on many mineral substances. The artificial production of potters' earth or clay is a very strong argument in support of this opinion. Potters' earth, as is well known, is found plentifully in most low grounds and vallies, between mountainous tracts, and where calcareous strata abound. By exposing common flint-stones to the confined vapour of boiling water in Papin's digester, a clay of the very same kind may be formed, and is no more than a decomposition of the flints. Hence it would appear, that wherever this clay is to be found, there the earth has undergone some violence from fire.

Chalk is no more than the ruins of sea-shells, and limestone consists of the same bodies cemented together by a stony juice. Amber appears evidently to be the resin of trees (which are frequently found along with it at this day) united to the acid of sea-salt, which abounds in the earth. The reason of insects, straws, &c. being immersed in amber, absolutely inexplicable from the hypothesis of its being of mineral origin, is now no more a secret; for we know that nothing is more common, than to find such bodies immersed in the resin of trees. Fossil sea-salt, or salt-gem, seems to have been deposited in the quarries, whence it is dug. All or most part of pit-coal appears to be of diluvian origin, for it gives a caput mortuum, the texture of which exactly resembles that of burnt wood. Large forests have been buried, which have undergone a fermentation and putrefaction in the earth, so that the colour of the woody part has been changed, though the texture has remained entire enough to allow us to distinguish to what kingdom it belongs. All bitumens, asphaltum, petrolæum, &c. seem to be no more than productions of resinous substances united with mineral acids, which have caught fire in the earth by fermenting with heterogeneous matter, and have thus undergone a sort of

natural distillation and exaltation. These are more than chimerical notions, and are even demonstrated by experiments; for amber can be produced artificially, as also bitumens by the distillation of resinous substances with mineral acids; and there is great probability that pit-coal might be imitated.

An Account of what happened at Bergemoletto, by the tumbling down of vast Heaps of Snow from the Mountains there, on March 19. 1755.

In the neighbourhood of Demonte, as in the upper valley of Stura, there were some houses in a place called Bergemoletto, which on the 19th of March, in the morning, were entirely overwhelmed and ruined by two vast bodies of snow that tumbled down from the upper mountain. All the inhabitants were then in their houses, except one Joseph Rochia, a man of about 50, who with his son, a lad of 15, were on the roof of his house, endeavouring to clear away the snow, which had fallen without any intermission for three preceding days. Whence perceiving a mass of snow tumbling down towards them from the mountain above, they had but just time to get down and flee, when, looking back, they perceived the houses were all buried under the snow. Thus 22 persons were buried under this vast mass, which was 60 English feet in height.

After five days, Joseph Rochia having recovered from his fright, and being able to work, got upon the snow, with his son, and two brothers of his wife's, to try if they could find the exact place under which his house and stable were buried; but though many openings were made in the snow, they could not find the desired place. On the 24th of April the snow was greatly diminished, and he conceived better hopes of finding out his house.

His wife's brothers, who lived at Demonte, went with Joseph and his neighbours to work upon the snow, where they made another opening, which led them to the house they searched for; but finding no dead bodies in its ruins, they sought for the stable, which was about 240 feet distant, and having found it, they heard a cry of "Help, my dear brother." Being greatly surprised as well as encouraged by these words, they laboured with all diligence till they had made a large opening, through which the brothers and husband immediately went down, where they found still alive, the wife about 45, the sister about 35, and a daughter

about 13 years old. These women they raised on their shoulders to men above, who drew them up, as it were from the grave, and carried them to a neighbouring house: they were unable to walk, and so wasted that they appeared like mere shadows. They gave the account that follows: that on the morning of the 19th of March they were in the stable, with a boy six years old, and the girl about 13: in the same stable were six goats, one of which having brought forth two dead kids the evening before, they went to carry her a small vessel full of gruel; there were also an ass and five or six fowls. Very fortunately the manger was under the main prop of the stable, and resisted the weight of the snow. Their first care was to know what they had to eat: the sister said, she had in her pocket 15 white chestnuts: the children said they had breakfasted, and should want no more that day. Two of the goats, however, were left alive, and were near the manger; one gave milk, with which they preserved their lives. The women affirmed, that during all the time they were thus buried they saw not one ray of light; yet for about twenty days they had some notion of night and day; for when the fowls crowed, they imagined it was break of day; but at last the fowls died.

The second day, being very hungry, they ate all the remaining chestnuts, and drank what milk the goat yielded, which for the first days was near two pounds a day, but the quantity decreased gradually.

On the sixth day the boy sickened, complaining of most violent pains in the stomach, and his illness continued six days; on the last of which he desired his mother, who all this time had held him in her lap, to lay him at his length in the manger, where he soon after died.

They say, during all this time, hunger gave them but little uneasiness, except on the first five or six days; that their greatest pain was from the extreme coldness of the melted snow-water which fell on them, and from the stench of the dead ass, dead goats, fowls, &c. but more than all from the very uneasy posture they were obliged to continue in; for though the place in which they were buried was 12 English feet long, eight wide, and five high, the manger in which they sat squatting against the wall was no more than three feet four inches broad. For 36 days they had no evacuation by stool after the first days: the melted snow-water, which after some time they drank without doing them harm, was discharged by urine. The mother said she had never slept, but the sister and daughter slept as usual.

An Essay towards ascertaining the specific Gravity of living Men By Mr JOHN ROBERTSON, F.R.S.

To make some experiments on this subject, Mr. R. got a cistern made, of 78 inches in length, 30 inches wide, and 30 inches deep; for men of different sizes to be immersed in. He then endeavoured to find ten persons, such as he proposed to make the experiments with: namely, two of six feet high, two of five feet ten inches, two of five feet eight inches, two of five feet six inches, and two of five feet four inches. A ruler, graduated to inches, and decimal parts of an inch, was fixed to one end of the cistern, and the height of the water noted before a man went in, and to what height it rose when he ducked himself under its surface; and of these several observations is the following table composed:—

No.	Heights. Ft.	In.	Wt. Pds.	Solidity. Cubic Feet.	Weight of Water. Pounds.
1	6	2	161	2.573	160.8
2	5	$10\frac{3}{8}$	147	2.586	161.6
3	5	$9\frac{1}{2}$	156	2.505	156.6
4	5	$6\frac{3}{4}$	140	2.763	172.6
5	5	$5\frac{7}{8}$	158	2.817	176.0
6	5	$5\frac{1}{2}$	158	2.939	183.7
7	5	$4\frac{1}{8}$	119	2.722	170.1
8	5	$3\frac{1}{8}$	13[illegible]	2.505	156.6
9	5	$4\frac{1}{8}$	121	2.424	151.5
10	5	$3\frac{1}{4}$	116	2.343	146.4

One of the reasons, that induced Mr. R. to make these experiments, was a desire of knowing what quantity of fir or oak timber would be sufficient to keep a man afloat in river or sea water, thinking that most men were specifically heavier than river or common fresh water; but the contrary appears from these trials; for, excepting the first and last, every man was lighter than his equal bulk of fresh water, and much more so than his equal bulk of sea-water: consequently, could persons, who fall into the water, have presence of mind enough to avoid the fright usual on such accidents, many might be preserved from drowning; and a piece of wood, not larger than an oar, would buoy a man partly above water so long as he had spirits to keep his hold.

On Polypes, Fossils, &c.

MONS. DONATI writes that he has thoroughly satisfied himself, by his late observations, that polypes are fixed to their cells. What he says afterwards of coral appears to express with more truth and precision what we ought to think of this kind of animals, than any of the descriptions which have been given since the new discoveries have changed our sentiments on that subject. Polype-beds, and the cells which they contain, are commonly spoken of as being the work of polypes. They are compared to the honey-comb made by bees. It is more exact to say that coral, and other coralline bodies, have the same relation to the polypes united to them that there is between the shell of a snail and the snail itself, or between the bones of an animal and the animal itself. Mons. Donati's words are as follow: "I am now of opinion, that coral is nothing else than a real animal, which has a very great number of heads. I consider the polypes of coral only as the heads of the animal. This animal has a bone ramified in the shape of a shrub. This bone is covered with a kind of flesh, which is the flesh of the animal. My observations have discovered to me several analogies between the animals of kinds approaching to this. There are, for instance, keratophyta, which do not differ from coral, except in the bone, or part that forms the prop of the animal. In the coral it is testaceous, and in keratophyta it is horny."

Mons. Donati observed several very curious facts in the journey which he made into the mountains. He has, in particular, traced out an immense bed of marine bodies. This bed crosses the highest mountains which separate Provence from Piedmont, and loses itself in the plains of Piedmont. He has likewise observed a mass of rock, which forms the extremity of a pretty high mountain, the foot of which is washed by the sea. This rock is, at a considerable height, entirely pierced by pholades, that species of marine shell-fish so well known, which digs cells in the stones. It hence appears, that this rock was some time covered by the sea. According to Mons. Donati, the sea has insensibly retired from the parts which were washed by it; and he thinks that there must have been a very considerable space of time between that and the time when this mountain, pierced by pholades, was covered by the waters of the sea. He deduces his opinion from the following fact. There is in this rock, pretty near the surface of the sea, a natural cavern

filled with water. In this earth have been found ancient Roman sarcophagi and lamps. Hence it follows that even in the time of the Romans this part of the rock, in which this cavern is situated, was not under water.

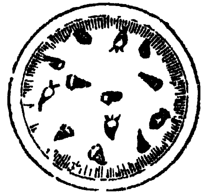
If all these different facts be compared together, it will not be doubted, but there are actually under the earth, marine bodies, which are found there only in consequence of slow revolutions, and not of an universal deluge. Perhaps this notion might be extended to the greatest part of the marine fossil bodies which are known to us.

On the Impressions of Plants on the Slates of Coals. By Mr. EMANUEL MENDES DA COSTA, *F.R.S.*

THE impressions of various kinds of plants are frequently, Mr. C. thinks always, found in some of the strata lying over coal; but more particularly in a stratum of earthy slate, which always lies immediately on the coal-stratum, not only in the coal-pits of this kingdom, but of many other parts of Europe, as France, Saxony, Bohemia, Silesia, &c. Most of these impressions are of the herbæ capillares et affines, the gramineous, and the reed tribes: but among them are many rare and beautiful impressions, undoubtedly of vegetable origin, and impressed by plants hitherto unknown to botanists. Besides these found over coal-pits, there are likewise found in some parts of this kingdom, as at Robin Hood's Bay, in Yorkshire, Colubrookdale, in Shropshire, &c. many curious impressions of the fern tribe, in regular nodules of iron-stone; and, in the latter place, not only impressions of plants, but even the cones or iuli of some kinds of trees are met with, very perfect and fair, and curiously imbedded in masses of iron-stone.

Most part of the impressions of ferns, grasses, &c. are easily recognisable, they so minutely tally to the plants they represent. Others, indeed, though they do not exactly answer any known species, yet have characters so distinctly expressed, that they are easily arranged under their respective genera. These impressions are not only met with in small pieces, but large evident branches, some feet in length, have been found. He had, in the collieries of Derbyshire, frequently traced branches with, seemingly, long narrow leaves proceeding from them, and parts of other vegetables, above a foot in length: but the hardness of the substance they are immersed in renders it impossible to get them out without breaking them to pieces.

Description of several small Marine Animals. By Job Baster, M.D.



If the sea-water round our coasts be moved by night, either by throwing a stone into it, or by a stick, it exhibits innumerable fiery sparks, which are no other than minute shining animalcules, requiring a good microscope to show them distinctly. In order to collect these animalcules in sufficient plenty, the way is to take a quantity of sea-water, in which they abound, and to strain it through a filtering paper, till only the quantity of about half an ounce, or less, remains on the paper: of this water a small drop, placed in a concave glass, and viewed by a microscope of considerable power, will exhibit them swimming very briskly about. Dr. B. observed three species, which are represented from the life, in the engraving.

Of some Fossil Fruits, and other Bodies, found in the Island of Sheppey. By James Parsons, M.D. F.R.S.

The kinds of wood fossil found here are of very different textures; and this, too, is according to the places where they are deposited. Some are seen so highly impregnated with a fine stony and pyritical matter, as to bear a polish like a pebble; some, though quite reduced to stone, yet preserving the fibrous appearance of the original state; and some, which are found in boggy bottoms, being not at all changed, except in colour: this is called bog-oak, or bog-deal. well known to country people in many places of these three kingdoms, who light themselves about their business with slips of this wood, cut on purpose, instead of candles, as it burns with a clear and durable flame. It is remarkable, that though oak or fir shall lie ages immersed in water under ground, it shall not putrefy, but acquire such sulphureous particles, by lying in steep in the bog-water, as to qualify it for this use. Other wood, deposited in marly ground, is found incrusted over, trunk and branches, with a white crust, the wood remaining entire within. At other times wood thus incrusted is eroded by the matter which covers it, having something acrimonious in its substance. We may add to these, clusters of the twigs of shrubs, and small wood, which we find flakes of, incrusted with sparry or calcareous matter, in many places; part of which are totally changed into that matter, whilst others are only enveloped with it.

Mr. Minors, an eminent surgeon and anatomist of the Middlesex Hospital, when he was in the army at Gibraltar, saw an entire skeleton, standing upright, in a dry rock, part of which had been blown up with gunpowder, in carrying on some works in the fortifications, which left the skeleton quite exposed. Indeed, the bones of elephants have been found in Sheppey Island, but much destroyed, their size and substance being so considerable, as to resist for a long time that decay which those of the human could not withstand. To these may be added the horns of large animals, as the elk, and others, which have been found in bogs, preserved as the bog-oak, &c. above mentioned.

The leaves of plants, whose fibres are firm and dry, will endure for a long time: but those of a succulent nature never can, as they putrefy very soon. We see the leaves of ferns of several kinds, polypodium, trichomanes, and other capillary plants, with nodules of stone formed about them; flags, reeds, rushes, equisetum, and many such, of a firm texture, are found in slate and stone; and even the iuli of trees are said to have been found fossil as their leaves.

All seeds, and the stones of fruits, having a firm texture, are also capable of being strongly impregnated with stony and pyritical matter; and doubtless the smaller seeds, if carefully looked for, might be found fossil, as well as these now produced, viz. such as have a firmness in the covering; but being small, and mixed with the dirt, sand, &c. probably is the reason of their being overlooked. Fruits of various kinds are found petrified; but this is only in their green state, when they are hard enough to endure till they are impregnated with stony or mineral particles.

Fig. 1.

Of impressions of fishes upon slate there are several kinds, which have such impressions on them: in some there remains only the bare impression, without any part of the fish; in others, the scales only, but retaining the entire form of the animal; and in others, no part adheres to the slate but the skeleton, or part of it, most commonly the spine. He says that he always observed, that the bones are never seen but on the grey or blue slate, or their impressions.

Fig. 2.

Fig. 3.

Fig. 1. a fig petrified when hard and green; fig. 2. coffee-berries; fig. 3. an exotic fruit, like a small melon.

On the Heat of the Weather in Georgia. By H. Ellis, *Esq.*

It is now (writes Mr. Ellis) about three o'clock; the sun bears nearly S W., and I am writing in a piazza, open at each end, on the N. E. side of my house, perfectly in the shade: a small breeze at S. E. blows freely through it; no buildings are nearer, to reflect the heat, than 60 yards: yet in a thermometer hanging by me, the mercury stands at 102°. Twice it has risen this summer to the same height; viz. on the 28th of June, and the 11th of July. Several times it has been at 100°, and for many days successively at 98°; and did not in the nights sink below 89°. It is highly probable that the inhabitants of this region breathe a hotter air than any other people on the face of the earth. The greatest heat we had last year was but 92°, and that but once: from 84° to 90° were the usual variations; but this is reckoned an extraordinary hot summer.

I have frequently walked 100 yards under an umbrella, with a thermometer suspended from it by a thread to the height of my nostrils, when the mercury has risen to 105°; which is prodigious. At the same time I have confined this instrument close to the hottest part of my body, and have been astonished to observe that it has subsided several degrees. Indeed I never could raise the mercury above 97° with the heat of my body. I have traversed a great part of the globe, not without giving some attention to the peculiarities of each climate; and I can fairly pronounce that I never felt such heats any where as in Georgia. I know experiments on this subject are extremely liable to error; but I presume I cannot now be mistaken, either in the goodness of the instrument, or in the fairness of the trials, which I have repeatedly made with it. This same thermometer I have had thrice in the equatorial parts of Africa; as often at Jamaica, and the West India islands; and on examination of my journals, I do not find that the quicksilver ever rose in those parts above the 87th degree, and to that but seldom: its general station was between the 79th and 86th degree; and yet I think I have felt those degrees, with a moist air, more disagreeable than what I now feel.

Yet these heats, violent as they are, would be tolerable but for the sudden changes that succeed them. On the 10th of December last, the mercury was at 86°; on the 11th it was so low as 38° of the same instrument.

Remarks on the several Accounts of the fiery Meteor, (which appeared on Sunday, the 26th of November, 1758,) and on other such Bodies. By JOHN PRINGLE, *M.D. F.R.S.*

THIS meteor seems to have been vertical at Cambridge, or nearly so, and to have appeared first there in a state of ignition. Thence it proceeded directly, almost N.W. by N., over several counties in England, over the Solway Frith, which it crossed between Carlisle and the town of Dumfries; and in Scotland over the shires of Dumfries and Lanerk; but soon after its becoming vertical to the last, viz. a few miles to the southward of Douglas, (or, perhaps, nearer to the borders of Lanerk and the shire of Ayr, about 10 or 12 miles to the eastward of Auchenleck,) part of the tail seemed to break off, and to disperse in bright sparks of fire; while the head, into which the remainder of the tail was instantly collected, moved on in the same direction, till coming over Fort William, in the shire of Inverness, after a course of about 400 miles, it there suddenly disappeared. But, notwithstanding the extinction of the meteor at this place, it seems still to have proceeded northwards; since it was seen again in a luminous state, in a globular form, but without a tail, about the 58° of latitude, on the western coast of the shire of Ross, almost vertical to the observer; moving then to the southward of the east, that is, in a direction almost contrary to the first; and in this last course, of which we know not the end, it possibly might have gone a great way to the eastward.

During the first part of its progress, viz. from Cambridge to Fort William, it went obliquely downwards in such a manner, that, by computation, it must have been from about 90 to 100 miles high at the first of these places, and between 26 and 32 miles at the last.

This dipping and rising in the course of a meteor is not more extraordinary than its lateral deviation from a straight line.

In regard to the velocity, it seems almost incredible; as we have sufficient data for computing it at the rate of 30 miles in a second. But if we allow that it only moved through half the space in that time, we shall find the progression of this body to have been above 100 times swifter than the mean celerity of a cannon ball, and nearly equal to that of the earth in its orbit round the sun.

As to its real size, we cannot pretend to determine that point with any precision, since its dazzling brightness would

occasion some deception, and the apparent magnitude has been so differently represented by the observers.

The body must have been of a considerable bulk to have yielded such a light, as that, when in the zenith of Cambridge, a farmer at Ancram, at the distance of above 260 miles, should, on entering his threshold, see the whole side of his house illuminated by it; and, to use his own expression, with a brightness as of sunshine.

As for the tail, it was a stream of light several miles in length: for this was no deception, like what we suppose the train of a shooting star to be, but was either a real flame, or, what is more probable, it consisted partly of flame, but mostly of smaller masses of fire, (which the observers call sparks, when falling out of the lucid tract,) and of vapours or fuliginous particles not heated red-hot, but illuminated by the parts actually burning. Perhaps these vapours were the chief part of the composition, and which will account for its light being so much fainter than that of the head; since in some places where the air was less clear, or the distance greater, we find the whole meteor described either as a round ball, or a spheroid (with the largest axis in the direction of its motion), but without a tail. In this last case, viz. that of the oval form, it is probable that, besides the head, the beginning of the tail was also visible, as consisting of flame, and therefore brighter than the rest; and that both together appeared oblong to those observers. But such as were nearest, and had a clear atmosphere, saw the tail of a considerable length; that is, the flame, the sparks, and the illuminated vapour in a train behind the head, as being lighter, and therefore meeting with more resistance from the air; in the same manner as the flame, the sparks, and smoke of a torch are seen to follow it. All this is plain; but in regard to that separation of the third part of the tail from the rest, a circumstance clearly described by the farmer at Ancram, and seemingly confirmed by other observations, there may be some difficulty.

The final report, so frequently mentioned, not only heard by those who saw the light, but by others who knew nothing of what had happened, was a real sound, immensely greater than any we are acquainted with. For, at the distance of 70 miles and upwards, it was compared to loud thunder, the report of heavy artillery, the fall of the gable-end of the house the person was in, and to a musket fired off in the garret. If this noise was produced when the body threw out those masses of burning matter, by the observers called sparks of fire, the bursting of the tail, &c. we shall find that at this

time the meteor, by being more than 41 miles high, was in a region where the air is 3000 times rarer than on the surface of the earth; that is, about six times rarer than in a common exhausted receiver, where sonorous bodies are not heard, and even where gunpowder and the pulvis fulminans take fire, and are exploded, but without noise.

Dr. P. also concludes from the great report, that the substance of the meteor was of a firmer texture than what could arise from mere exhalations, whether formed into a sphere, and then burning, or disposed into a kind of train, and consumed by a running fire; for sounds, as far as we know, are either produced by the quick and violent percussions of hard bodies on the air, or by the sudden expansion of an elastic fluid, after being condensed within some solid substance. To these arguments for the solidity of this body, we may add its extreme velocity, and the intensity of the light; which are, likewise, circumstances more conformable to a heavy and solid substance than to one formed of exhalations only.

If it is, then, probable, that these balls of fire come from regions far beyond the reach of our vapours; if they approach often so near to the earth, and so seldom or never touch it; if they are moved with so much celerity, as in that respect to have the character of celestial bodies; if they are seen flying in all directions, and, consequently, have a motion of their own, independent of that of our globe, surely we are not to consider them as indifferent to us, much less as fortuitous masses, or trains of terrestrial exhalations in the ethereal regions.

The regular diurnal Variation of the horizontal magnetic Needle. By JOHN CANTON, *M.A. F.R.S*

THE number of days on which these observations were taken was 603; and the diurnal variation on 574 of them was regular; that is, the absolute variation of the needle westward was increasing from about eight or nine o'clock in the morning till about one or two in the afternoon, when the needle became stationary for some time; after that, the absolute variation westward was decreasing, and the needle came back again to its former situation, or near it in the night, or by the next morning. The diurnal variation is irregular when the needle moves slowly eastward in the latter part of the morning, or westward in the latter part of the afternoon; also when it moves much either way after night, or suddenly oth ways within a short time. These irregularities seldom

happen more than once or twice in a month, and are always accompanied (so far as he had been able to observe) with an aurora borealis.

For the sake of those who may be desirous of examining the diurnal variations of the needle very minutely, Mr. C. annexed a complete year's observations; and deduced from the regular variations during that time the mean diurnal variation belonging to each month: whence it appears that the diurnal variation increases from January to June, and decreases from June to December.

The mean diurnal Variation for each Month in the Year 1759.

January	7	8	July	13	14
February	8	58	August	12	19
March	11	17	September	11	43
April	12	26	October	10	36
May	13	0	November	8	9
June	13	21	December	6	58

Conjectures concerning the Cause, and Observations on the Phenomena, of Earthquakes; particularly of that great Earthquake of Nov. 1. 1755, which proved so fatal to the City of Lisbon. By the Rev. JOHN MICHELL, *M.A.*

It has been the general opinion of philosophers, that earthquakes owe their origin to some sudden explosion in the interior of the earth. This opinion is agreeable to the phenomena which seem to point out something of that kind. That these concussions should owe their origin to something in the air seems very ill to correspond with the phenomena. This will sufficiently appear, as those phenomena are hereafter recounted; nor does there appear to be any such certain and regular connection between earthquakes and the state of the air, when they happen, as is supposed by those who hold this opinion.

Let us, then, rejecting this hypothesis, suppose that earthquakes have their origin under ground, and we need not go far in search of a cause, whose real existence in nature we have evidence of, and which is capable of producing all the appearances of these extraordinary motions. The cause I mean, says Mr. M., is subterraneous fires. These fires, if a large quantity of water should be let out upon them suddenly, may produce a vapour, whose quantity and elastic force may be fully sufficient for that purpose. The principal

facts, from which I would prove, that these fires are the real cause of earthquakes, are as follow:—

The same places are subject to returns of earthquakes, not only at small intervals, for some time after any considerable one has happened, but also at greater intervals of some ages. The returns of earthquakes in the same places, at longer distances of time, are confirmed by all history. Constantinople, and many parts of Asia Minor, have suffered by them, in many different ages: Sicily has been subjected to them, as far back as the remains even of fabulous history can inform us of: Lisbon did not feel the effects of them for the first time in 1755: Jamaica has frequently been troubled with them, since the English first settled there; and the Spaniards, who were there before, used to build their houses of wood, and only one story high, for fear of them: Lima, Callao, and the parts adjacent, were almost totally destroyed by them twice, within the compass of about 60 years: nor were these the only instances of the like kind which happened there; for, from the year 1582 to 1746, they have had no less than 16 very violent earthquakes, besides an infinity of less considerable ones; and the Spaniards, at their first settling there, were told by the old inhabitants, when they saw them building high houses, that they were building their own sepulchres.

Those places that are in the neighbourhood of burning mountains are always subject to frequent earthquakes; and the eruptions of those mountains, when violent, are generally attended with them. Asia Minor and Constantinople may be considered as in the neighbourhood of Santerini. The countries also about Etna, Vesuvius, Mount Hecla, &c. afford us sufficient proofs to the same purpose. But of all the places in the known world, probably no countries are so subject to earthquakes as Peru, Chili, and all the western parts of South America; nor is there any country in the known world so full of volcanoes: for, throughout all that long range of mountains, known by the name of the Andes, from 45° south latitude to several degrees north of the line, as also throughout all Mexico, being about 5000 miles in extent, there is a continued chain of them.

The motion of the earth in earthquakes is partly tremulous, and partly propagated by waves, which succeed one another sometimes at larger and sometimes at smaller distances; and this latter motion is generally propagated much farther than the former. The former part of this proposition wants no confirmation: for the proof of the latter, viz. the wave-like motion of the earth, we may appeal to many accounts of

earthquakes: it was very remarkable in the two which happened at Jamaica in 1687–8 and 1692. In an account of the former, it is said, that a gentleman there saw the ground rise like the sea in a wave, as the earthquake passed along, and that he could distinguish the effects of it to some miles distance, by the motion of the tops of the trees on the hills. Again, in an account of the latter, it is said, "the ground heaved and swelled like a rolling swelling sea," insomuch that people could hardly stand on their legs by reason of it. The same has been observed in the earthquakes of New England, where it has been very remarkable. A gentleman giving an account of one that happened there, Nov. 18. 1755, says, the earth rose in a wave, which made the tops of the trees vibrate 10 feet, and that he was forced to support himself, to avoid falling while it was passing. The same also was observed at Lisbon, in the earthquake of the 1st Nov. 1755, as may be plainly collected from many of the accounts that have been published concerning it, some of which affirm it expressly; and this wave-like motion was propagated to far greater distances than the other tremulous one, being perceived by the motion of waters, and the hanging branches in churches, through all Germany, among the Alps, in Denmark, Sweden Norway, and all over the British isles.

It is observed in places which are subject to frequent earthquakes, that they generally come to one and the same place from the same point of the compass. It may be added, also, that the velocity with which they proceed (as far as one can collect it from the accounts of them) is the same; but the velocity of the earthquakes of different countries is very different.

In the earthquake of Nov. 1. 1755, we are told that both smoke and light flames were seen on the coast of Portugal, near Colares; and that on occasion of some of the succeeding shocks, a slight smell of sulphur was perceived to accompany a "fog, which came from the sea, from the same quarter whence the smoke appeared." In an account of an earthquake in New England, it is said that at Newbury, 10 miles from Boston, the earth opened, and threw up several cartloads of sand and ashes; and that the sand was also slightly impregnated with sulphur, emitting a blue flame when laid on burning coals. One of the relaters of the earthquake in Jamaica, in 1692, has these words: "In Port-Royal, and in many places all over the island, much sulphureous combustible matter has been found (supposed to have been thrown out on the opening of the earth), which on the first touch of

fire would flame and burn like a candle. — St. Christopher's was heretofore much troubled with earthquakes, which, on the eruption there of a great mountain of combustible matter, which still continues, wholly ceased, and have never been felt there since."

The earth (as far as one can judge from the appearances) is not composed of heaps of matter casually thrown together, but of regular and uniform strata. These strata, though they frequently do not exceed a few feet, or perhaps a few inches in thickness, yet often extend in length and breadth for many miles, and this without varying their thickness considerably. Beside the horizontal division of the earth into strata, these strata are again divided and shattered by many perpendicular fissures, which are in some places few and narrow, but oftentimes many, and of considerable width.

The returns of earthquakes in the same places, either at small or large intervals of time, are consistent with the cause assigned: subterraneous fires, from their analogy to volcanoes, might reasonably be supposed to subsist for many ages, though we had not those instances already mentioned which put the matter out of doubt. And as it frequently happens that volcanoes rage for a time, and then are quiet again for a number of years, so we see earthquakes also frequently repeated for some small time, and then ceasing again for a long term, excepting, perhaps, now and then some slight shock. And this analogy between earthquakes and the effects of volcanoes is so great, that he thinks it cannot but appear striking to any one who will read the accounts of both, and compare them together.

The frequency of earthquakes in the neighbourhood of burning mountains is a strong argument of their proceeding from a cause of the same kind; and the analogy of several volcanoes lying together in the same tract of country, as well as new ones breaking out in the neighbourhood of old ones, tends greatly to confirm this opinion; but what makes it still the more probable is, that peculiarity in the structure of the earth before mentioned. It has been already observed, that the same strata are generally very extensive, and that they commonly lie more inclining from the mountainous countries than the countries themselves: these circumstances make it probable that those strata of combustible materials, which break out in volcanoes on the tops of the hills, are to be found at a considerable depth under ground in the level and low countries near them.

If we suppose that these vapours, when pent up, are the

cause of earthquakes, we must naturally expect that the most extensive earthquakes should take their rise from the level and low countries; but more especially from the sea, which is nothing else than waters covering such countries. Accordingly, we find that the great earthquake of Nov. 1. 1755, which was felt at places near 3000 miles distant from each other, took its rise from under the sea; as is manifest from that wave which accompanied it. The same thing is to be understood of the earthquake that destroyed Lima, in the year 1746, which, it has been said, was felt as far as Jamaica; and as it was more violent than the Lisbon earthquake, so if this be true, it must probably have been more extensive also. There have been many other very extensive earthquakes in South America: Acosta says that they have been often known to extend themselves 100, 200, or 300, and some even 500 leagues along the coast. These have been generally, if not always, attended with waves from the sea.

Of artificial Cold produced at Petersburgh. By Dr. Himsel.

On December 14, 1759, they had at Petersburgh the most excessive cold weather that ever was known, even to 205° of De Lisle's thermometer, or 34° below zero in Fahrenheit. At that time Professor Braun repeated Fahrenheit's experiments in order to produce excessive cold, by means of spirit of nitre combined with snow. He saw, with surprize, the quicksilver fall considerably in the thermometer, and descend even to 470° at last: there the quicksilver remained fixed in the open air for the space of a quarter of an hour, and did not begin to rise till it was carried into a warm room. The immobility of the quicksilver made him conjecture that it might be frozen, or become a solid body. — Dec. 25. in the morning, between nine and ten, De Lisle's thermometer was at the 199th degree of cold; and Mr. Braun, as well as Professor Æpinus, then repeated this experiment. As soon as the former had observed the quicksilver immovable in the thermometer, he broke the glass; and he found the quicksilver frozen, but not entirely; for in the middle of the glass ball there was a small portion yet remaining fluid. Mr. Æpinus's thermometer fell with extreme rapidity almost to the 500th degree, and in breaking the glass from below, he found the quicksilver contained in it absolutely frozen. Both these gentlemen found that the quicksilver, thus rendered solid, bore hammering and extension, like other metals; but, being afterwards exposed to the open air, it soon recovered

its former fluidity. Mr. Æpinus went further in order to examine the quicksilver when it was made solid. He poured quicksilver into a glass tube as thick as one's finger, closed at bottom, but open at top. The quicksilver in this cylinder, which was about one inch and a half long, froze in three quarters of a minute; and he observed that it became solid, perfectly resembling other metals, except iron: it continually contracted, and its surface, which was at first pretty high, soon sunk very low. This cylinder of frozen quicksilver sunk to the bottom of fluid quicksilver, in the same manner as is observed of other metals except iron. We know the contrary happens with regard to water frozen and other fluids, which extend as they become solid, and their ice swims in the fluid matter of which they were produced.

Dec. 26. in the morning, between nine and ten, the cold became extremely sharp at 211°, and such as exceeded the greatest degree of artificial cold fixed by Fahrenheit, for 40° below zero, in Fahrenheit's thermometer, is equal to 210° of that of De Lisle.

Mr. Braun repeated this experiment again exactly with the same success with that of the day before. The Counsellor and Professor Lomonossow made the same experiment on the same day; and by means of aquafortis the cold came to 195 degrees. He then poured in spirit of common or sea salt, and the quicksilver fell down in the thermometer to 554 degrees; and in taking the thermometer from the mixture the quicksilver continued to fall in the open air to the 552d degree. He threw yet into the glass a little more snow, pouring on it some oil of vitriol, and suddenly the quicksilver fell to 1260 degrees. He then broke the ball, and found the mercury changed to a solid body. The quicksilver, which yet remained in the tube, was also become solid, and appeared like a loose silver wire attached to the ball, which was flexible every way. He gave the ball of quicksilver several blows with a turned axe, and it became flat like a half ruble, or English half crown; but receiving thereby some cracks, it dissolved in about 20 minutes. These experiments were made when the air was at about 208 degrees of cold.

Of a Whirlwind in New England. By Mr. John Winthrop, Prof. of Phil. at Cambridge, U. S.

The morning of July 10. was fair and hot, with a brisk gale at south-west. At Leicester, 40 miles westward, about five o'clock the sky looked strangely; clouds from the south-west

and north-west seemed to rush together very swiftly, and immediately on their meeting commenced a circular motion; presently after which a terrible noise was heard. The whirlwind passed along from south-west to north-west. Its first effects were discernible on a hill, where several trees were thrown down at considerable distances from each other. In this manner it proceeded the distance of six miles with the most destructive violence, tearing up and scattering about the trees, stones, fences and every thing else in its way, forming a continued lane of ruins, of a few rods wide.

It met with only one dwelling-house in its course, that of one David Lynde, on which it fell with the utmost fury, and in a moment effected its complete destruction. The house was of wood, two stories high, and both the chimnies of stone. Near the house were a shop and small shed; and the barn stood on the opposite side of the road, about 10 rods distant. As soon as they perceived the storm coming near the house some men within endeavoured to shut the south door; but before they could effect it they were suprised by the falling of stones around them, from the top of that chimney which was in the middle of the house. All the people in the house were in that instant thrown into such a consternation, that they can give no account of what passed during this scene of confusion, which was indeed very short. Where the house stood nothing remained but the sills, and the greater part of the lower floor, with part of the two stacks of chimnies, one about 10 feet, and the other not quite so high; the stones which had composed the upper part lying all around them. Except these sills, there were only three pieces of timber, and those very large, left entire; one of which, about 16 feet long, and 10 inches by eight, was found on the opposite side of the road, nearly south, about 20 rods distant from the house. The rest of the timbers, from the greatest to the least, lay broken and twisted to pieces between N. N. E. and E. for 70 or 80 rods from the house; some on the ground, others sticking into it a foot and two feet deep in all directions. Part of one of the main posts, about 10 feet long, with part of one of the plats of nearly the same length, and a brace which holds them together, were left sticking in the ground, nearly perpendicular, to a great depth, in a field southerly from the house about eight rods distant. The boards and shingles of the house, with 3000 or 4000 new boards which lay by it, were so entirely shattered, that scarcely a piece could be found above four or five inches wide, and vast numbers were not more than two fingers wide. some within the course of the wind and some without, at

great distances on both sides of it. What has been said of the boards and shingles was likewise true of the wooden furniture of the house: the tables, chairs, desks, &c. shared the same fate; not a whole stick was to be found of any of them. Some of the beds that were found were hanging on high trees at a distance. Of the heavy utensils, pewter, kettles, and iron pots, scarcely any were found. Some nails that were in a cask in the east chamber were driven in great numbers into the trees on the eastern side of the house. The shop and shed before mentioned were torn in pieces, nothing of the shop remaining but the sills and floor; and a horse standing under the shed was killed. Only one person was killed.

From the whole, it seems highly probable that the house was suddenly plucked off from the sills (to which the upright posts are not fastened), and taken up into the air, not only above the heads of the persons who were on the lower floor, but to the height of those parts of the chimnies which were left standing, where, by the violent circular motion of the air, it was immediately hurled into ten thousand pieces, and scattered to great distances on all quarters, except that from which the wind proceeded. And it further appears, that the violence of the wind in that place was over as soon as the house was taken up.

Burning Cliffs in Dorsetshire. By JOHN STEPHENS, *M.A.*

IN August, 1751, the air, having been for some time remarkably hot and dry, was changed suddenly by a heavy fall of rain, and a high south-west wind. The cliffs near Charmouth, in the western part of Dorsetshire, presently after this alteration of the atmosphere, began to smoke, and soon after they burned, with a visible though a subtle flame for several days successively; and continued to smoke, and sometimes to burn at intervals, till the approach of winter: nay, ever since that time, especially after any great fall of rain, thunder, and lightning, or a high south-west wind, (which drives the sea with great violence against the cliffs, and beats off large pieces of them,) the cliffs continue to smoke, and sometimes to burn with a visible flame; which during the summer-months is frequently observed in the night-time. On examining these cliffs, in the year 1759, Mr. S. discovered a great quantity of pyrites, not in any regular strata, but interspersed in large masses through the earth, and which proved to be martial; of marcasites, which yielded near one tenth part of common sulphur; of cornua ammonis of dif-

ferent sizes, and other shells, but of the bivalve class, which were crusted over, and as it were mineralised with the pyritical matter; of belemnites, also crusted over with the like substance: and the cliffs, for near two miles long, and from the surface, to 35 or 40 feet deep, even to the rocks at high water-mark, were one bed of a dark-coloured loam, strongly charged with bitumen. He found also a dark-coloured substance, resembling coal-cinder; some of which being powdered, and washed in distilled rain-water, on filtrating the water, and evaporating it slowly to a pellicule, its salts shoot into fine crystals, and appear to be no more than a martial vitriol: one ounce of this cinder-like substance yields one drachm of salt. He gathered up about 100 lb. weight of the different kinds of those pyritæ, marcasites, &c. which were laid in a heap exposed to the air, and every day sprinkled with water: the consequence was, that in about ten days' time they grew hot, soon after caught fire, burned for several hours, and fell into dust. Hence, therefore, it is imagined that these martial and sulphureous fossils, by being exposed to the air and wet, and by being agitated by the beating of the sea, take fire.

From what has been said Mr. S. draws the following conclusions: —

1. That all subterraneous fires, even those of Hecla, Vesuvius, and Ætna, together with those observed in the mines and coal-pits, are caused by the heat and fixing of pyrites and marcasites. 2. That the waters of our hot baths derive their heat from passing over a bed of ignited pyrites. Indeed the solid contents of those waters do evidently prove this assertion, being nothing more than such particles of the pyrites as are soluble in water. 3. That these mineral flames will be more or less subtle, according to the minuteness of the particles of the combustible matter. 4. That the convulsive motions and tremblings of the earth are caused by the heat of the burning pyrites expanding the air contained in its bowels. This is clearly proved by their causing, immediately after, an eruption of the earth, which generally discharges a dark-coloured, cinder-like, and frothy matter. And, 5. That those places, where the earth contains the greatest quantity of pyrites and marcasites, will be most liable to these convulsive motions and tremblings, no other natural cause contradictory.

On the Extraordinary Agitation of the Waters in Mount's Bay, and other Places, March 31. 1761. By the Rev. W. Borlase, M. A. F. R. S.

March 31. 1761, about five in the afternoon, there was an uncommon motion of the tide in Mount's Bay, Cornwall. It was full sea that day about half an hour after 12. After the tide had ebbed about four hours and a half, instead of continuing to retreat gradually, as usual, till it had completed the six hours' ebb, on a sudden it advanced as it is usually at the time of the moon, at an hour and a half before high water. It then retreated near to the point of low water, then it advanced again, and retreated, making five advances, and as many recesses in the space of one hour; viz. from about five to six o'clock, which was the whole time that these uncommon stretches of the tide continued. But the first motion was most considerable, the sea advancing the first time to a quarter ebb; whereas the second advance was but as far as the sea reaches at half ebb. At the first surge the waters rose at this place six feet perpendicular.

On the coast of Scotland, from Fort Augustus on Lochness, we had accounts that on the same 31st of March, about two in the afternoon, Lochness rose on a sudden about two feet perpendicularly, and continued alternately rising and falling for the space of three quarters of an hour. The King's galley broke from her moorings, and drove into the loch: several boats were cast very far upon dry land: in the middle of the loch the water swelled up like a mountain, extremely muddy, and the motion was attended with a very uncommon hollow sound.

On the coast of Ireland, from Cork, there was advice that on the same 31st of March, a quarter after noon, a shock of an earthquake was felt in that city, and between the gates only, allowed to be more violent than that of November 1. 1755. It did not continue above one minute, undulating from east to west, and vice versâ. At Kinsale, about six o'clock P. M. near dead low water, the tide rose suddenly on the strand, about two feet higher than it was, and went out again in the space of four minutes with great force, which was repeated several times; but the first was the greatest. At Amsterdam the branches in the synagogue were observed to vibrate between one and two o'clock. In the great church at Maesland-Slys, the branches moved about a foot from the perpendicular, and the vessels in the harbour were agitated.

But this earthquake was felt more violently on the ocean,

between the coasts of Spain and the British Channels. Ships on their passage from that part of the continent, many leagues to the westward of Cape Finisterre, felt an unusual agitation of the sea, as if they had struck on sunken rocks: the time agreeing with that of Cork and Fort Augustus. Captain Woodward, of the Expedition packet-boat, sailed from Lisbon, March 29. On the 31st, soon after he had passed the rocks of Lisbon, in the morning, and almost calm, the sea swelled to a great degree, with a rumbling noise. The vessel was tossed about as if in a storm. The agitation continued four minutes.

The Gosport man of war, off the rock of Lisbon, at three quarters past 11 in the forenoon, felt two violent shocks of an earthquake; the first continued near a minute and a half, the second not so long. Under the convoy of the Gosport were several ships, all affected in the same manner. One off Lisbon felt the shock, attended with a noise, as if empty casks had been tossed about in the hold.

In the latitude 43°, not many leagues off shore, in her passage from Lisbon, the Amey of Bristol, Captain Condon. felt a most violent shock. The concussion was so great, that it shook the needle off the spindle of the compass; and immediately after arose such a storm of wind and rain as he never before met with. The shock was felt 10 minutes A.M. viz. half an hour before it was felt at Cork, and five hours before the waters rose at Kinsale, and in Mount's Bay on the same day.

At the same time there was a violent earthquake at Lisbon, thought by some as severe as that of 1755, but the agitation more equable; consequently the damages were not so deplorable, a few old houses were shattered and thrown down, and some new ones cracked: the shock lasted between three and five minutes. But more particular is the account following, from an eye-witness, in an English vessel then off Lisbon, *i.e.* lying before the city. "On March 31st, at mid-day, a severe shock, not so strong as that of 1755, but of longer duration. I saw the ruins of the last earthquake falling heap upon heap, and turning round beheld the rocks on the opposite side falling from the mountains, followed by a continual cry of the people: the buildings erected since 1755 damaged to the amount of 20,000 moidores at least. It lasted about five minutes, some say seven; the water in continual agitation all the afternoon, ebbing and flowing three or four feet in a very short time. At 12 at night another shock, of short continuance; that night three more; did no

damage. St. Ubes, 10 leagues distance to the south, has suffered much; and the villages to the north, as also a large convent. During the confusion in the city, 300 persons in the several gaols gained their liberty. The shock felt at Oporto was very strong, but did no damage. At a village about 20 miles distant, three or four houses were thrown down, by which several people were killed."

At Madeira the shock was felt very violent at 10 o'clock A.M. It did no damage in the town: some rocks were split, and fell into the sea, and some of the roads of the island suffered. The greatest damage there sustained was the loss of one church, and four people killed, two of which were in a boat fishing near the shore, when the rocks fell.

At Fyal island, one of the Azores, and Terceira, the sea rose to a great height, and fell again so low that the quays were left dry: all the lighters and fishing-boats that were hauled up in Portorico, were carried down into the bay, and broken to pieces on the rocks. About a fortnight after, several earthquakes (successively more and more violent) ended not, till on the 20th three volcanoes threw out as many rivers of lava, of near a mile in breadth, and four yards high, which threatened desolation to the whole country, and continued overrunning every tree and house till the 24th.

From these accounts, the violence of this earthquake was greatest at, or rather near, Lisbon; perhaps at sea, in latitude between 43° and 44°, and longitude about 11° 19', where no tremors of land could be observed, and consequently the effects not so terrifying, nor perceived by so many, nor so destructive as if it had happened on the land, and contiguous to Lisbon, as that of 1755. The weather various in the different places, but mostly calm.

There was a great conformity between the effects of the earthquake of Nov. 1. 1755, and of this of March 31. 1761; viz. in the extent; in the rise of the waters; in the calmness of the weather in most parts; and in the succession of time, beginning sooner at Lisbon than on the northern shores both times.

Account of a Mummy inspected at London in 1763. By JOHN HADLEY, *M.D. F.R.S.*

THE mummy was an entire one, taken out of the Royal Pyramids. The outer painted covering being removed, nothing but linen fillets were to be seen, which enclosed the whole mummy. These fillets were of different breadths; the

greater part about an inch and a half; those about the feet much broader: they were torn longitudinally; those few that had a selvage, having it on one side only; the uppermost fillets were of a degree of fineness nearly equal to what is now sold in the shops for 2*s*. 4*d*. per yard, under the name of long lawn; and were woven something after the manner of Russia-sheeting: the fillets were of a brown colour, and in some measure rotten. These outer fillets seemed to owe their colour to having been steeped in some gummy solution; as the inner ones were in pitch.

The fillets immediately under the painted covering lay in a transverse direction; under these, which were many times folded, they lay oblique, diagonally from the shoulders to the ilia. Under these the fillets were broader, some nearly three inches; and lay longitudinally from the neck to the feet, and also from the shoulders down the sides; on which there was a remarkable thickness of these longitudinal fillets: under these they were again transverse, and under these again oblique. The fillets, in general, externally, did not adhere to each other; but though pieces of a considerable length could be taken off entire, yet, from the great age, so tender was the texture of the cloth, that it was impossible regularly to unrol them. As the outer fillets were removed, those that next presented themselves had been evidently steeped in pitch, and were in general coarser, in folds, and more irregularly laid on; as they were more distant from the surface. The inner filleting of all was so impregnated with pitch, as to form with it one hard black brittle mass; and had been burned nearly to a coal. On breaking this, it appeared in many places as if filled with a white efflorescence; like that observable on the outside of pyrites which have been exposed to the air. This efflorescence, however, had nothing saline to the taste, and did not dissolve in water; but instantly disappeared, on bringing it near enough to the fire to be slightly heated; and was soluble in spirit of wine.

In the cavity of the abdomen were found several small pieces of bone, which had the appearance of dry oak, mixed with crumbled pitch; under this was found more solid pitch, which adhered to the spine. After cutting away the mass of cloth and pitch which covered the thorax; it was found that the arms had been laid straight down by the sides of the chest, and the ulna and radius bent upwards, and laid with the hands across upon the breast, the right hand being uppermost. The bones of the fingers were lost; but the metacarpal bones were found broken off, and fallen into the thorax. The fillet-

ing, which went round the upper part of the body, included the arms also; but they had evidently been first wrapped separately, then laid up in the position in which they were found, and the hollows which they formed filled up with pieces of pitched cloth. In the cavity of the thorax there was also a considerable quantity of crumbled pitch and splinters of dry bone; and, as in the progress of this examination Dr. H. continually found that some of the bones did, as he laid them bare, separate into such splinters, it is very probable that this appearance was owing to the mummy's having been handled in a rough manner, and much shaken, by the persons who had driven it full of nails, when they were employed to repair the outside of it. On first opening a way into the thorax, he imagined the ribs were destroyed; but, on a more accurate examination, they were found entire; but so bedded in the pitch, and so black and burned into the mass, as to make it difficult to distinguish these very different substances from each other. The bones of the spine and of the pelvis were in the same state with the ribs; only rather more burned.

There was a considerable thickness of hard sold pitch lining the cavity of the thorax: this had been evidently liquified and poured in; and retained that glossy appearance on its surface which is observable on pitch that is suffered to cool without being disturbed. On breaking through this hard crust of pitch to examine the vertebræ and the ribs, the pitch which was under this crust and nearest to the bones was crumbly and soft; and, on being exposed to the air, grew perfectly moist in a very short time. The lower extremities were wrapped separately in fillets to nearly their natural size, and then bound together; the interstices being rammed full of pitched rags. On cutting through the fillets on the thighs, the bones were found invested with a thin coat of pitch; and the filleting was bound immediately on this. The tibia and fibula of each leg were found also wrapped in the same manner, and the bones in actual contact with the pitch; excepting in one or two places, where the pitch was so very thin, that the cloth appeared to adhere to the bone itself.

The feet were filleted in the same manner, being first bound separately, and then wrapped together. The filleting had been by some accident rubbed off the toes of the right foot; and the nail of the great toe was found perfect; the last joints of the bones of the lesser toes had been broken away; by which it appeared that these bones had been penetrated, and their cavities quite filled with pitch. The filleting about the heel had also been broken away, and the bones

of the tarsus, and some of the metatarsal bones, had fallen out and were lost; leaving the remaining filleting like a kind of case. The fillets on the left foot were perfect; except on the heel, and where they had been divided from those of the leg, a small portion of the tendino Achillis adhered to the os calcis; and some of the ligaments to the astragalus. On cutting into the fillets on the sole of this foot they were found to enclose a bulbous root. The appearance of this was very fresh; and part of the thin shining skin came off with a flake of the dry brittle filleting with which it had been bound down: it seemed to have been in contact with the flesh.

The fillets were removed from this foot with great care: they were much impregnated with pitch, excepting about the toes; where the several folds, united into one mass, being cut through, yielded to the knife like a very tough wax. The toes being carefully laid bare, the nails were found perfect on them all; some of them retaining a reddish hue, as if they had been painted: the skin, also, and even the fine spiral lines on it, were still very visible on the under part of the great toe, and of the three next adjoining toes. Where the skin of the toes was destroyed, there appeared a pitchy mass, resembling in form the fleshy substance; though somewhat shrunk from its original bulk. The natural form of the flesh was preserved also on the under part of the foot; near the bases of the toes. On the back of the toes appeared several of the extensor tendons.

During this whole examination, excepting what was discovered in the feet, there were not found the least remains of any of the soft parts. All the bones of the trunk were bedded in a mass of pitch; and those of the limbs were covered with a thin coat of it, and then swathed in the fillets: which (as has been mentioned) in some places, where the pitch was very thin, seemed to adhere to the bone itself.

It has been imagined, that the principal matter used by the Egyptians for embalming, was the asphaltus; but what Dr. H. found was certainly a vegetable production. The smell in burning was very unlike that of asphaltus; nor did it resemble that of the common pitch of the fir-tree; being rather aromatic. It was compared with a variety of resins and gum-resins; but it seemed not to resemble any of them, excepting myrrh, and that but very slightly. In all probability it was not a simple substance, but might be a mixture of the resinous productions of the country, with the pitch of that tree which they had in greatest plenty.

The pitch of this mummy was carefully distilled, but it

gave no other produce than what might be expected from a resinous body; the caput mortuum, when burned and elixated, yielded a fixed alkali; to this may be attributed the moisture which the pitch, that was in contact with the spine, and those other parts which were most burned, contracted on being broken and exposed to the air; for this pitch had an alkaline taste, and had been more than melted, having been burned to a caput mortuum. A great variety of experiments were made on this pitchy matter: the result of them all tended to prove, that it had not the least resemblance to asphaltus, but was certainly a vegetable resinous substance.

Observations on the Proportion which the Decrease of Heat bears to the Height of Situation. By THOMAS HEBERDEN, *M.D. F.R.S.*

THE remarkable transition from heat to cold in all seasons, in proportion as we ascend Teneriffe, induced Dr. H. to make the following observations, with intention to discover if there subsists any regularity between the difference of heat and the elevation of situation. Some persons were supplied by him with the proper instruments, and their watch adjusted by his regulator: they were instructed to remark the hour and minute each observation was made, and, on their return, their observations were compared with the height of the thermometer and barometer in his study at the time of the observation, of which he had kept an exact account during the journey. From which observations he formed the following table, supposing the descent of the barometer $\frac{1}{10}$ of an inch for every 90 feet: —

Descent of Thermom.	Elevat. corresponding to each Degree of Thermometer.
Degrees.	Feet.
2	180
5½	196 +
6	195
9	150
10	148.5
17	198
19	199
18	255

Though the different degrees of heat in different places must depend greatly on the accident of situation, with regard to mountains, vallies, and to the different soils, &c. yet there is so much regularity in the above observations, that perhaps

we shall not err much in computing, where the soil and surface are tolerably uniform, "the decrease of heat, by Fahrenheit's thermometer, in the proportion of one degree for near 190 feet of elevation on this island"

On the Nature and Formation of Sponges. By JOHN ELLIS, *Esq. F.R.S.*

AMONG those animals commonly called zoophytes, we may plainly discover an evident approximation, from the rudest irregularly formed sponge, which is the lowest being yet observed to have the appearance of animal life, to the most beautiful and elegant red coral. The nature and formation of sponges having never yet been thoroughly investigated, every attempt to explain this dark part of nature must give satisfaction to the curious

In the year 1762, when at the sea-side at Brighthelmstone, he dissected carefully the crumb of bread-sponge, in hopes of discovering the small animal that was supposed to fabricate them; and was surprised to find a great number of small worms in them, particularly a very small kind of nereis, or sea-scolopendra; but these worms appeared evidently, instead of being the fabricators of it, to have pierced their way into its soft substance, and made it only their place of retreat and security. After this, he proceeded along the sea-coast to Little Hampton, near Arundel, on the coast of Sussex, where he took up out of the sea several specimens of the same sort of sponge full of an orange-coloured gelatinous matter; and, while they were just fresh from the sea, examined them, after they had rested for some time, in glasses of sea-water; and to his great surprise, instead of seeing any of the polype-like suckers, or any minute animal figure come out of the papillæ, or small holes with which they are surrounded, he only observed these holes to contract and dilate themselves. And as a further confirmation of this motion, being at Hastings, in Sussex, in August, 1764, he collected from the rocks, at ebb-tide, just under water, a variety of the same kind of sponge, but of a pale yellow colour, and in the form of several cocks' combs united together, the tops of which were full of tubular cavities, or papillæ; when he examined these in glasses of sea-water, he could plainly observe these little tubes to receive and pass the water to and fro; so that the sponge is an animal sui generis, whose mouths are so many holes or ends of branched tubes opening on its surface; with these it receives its nourishment, and by these it discharges, like the polypes, its excrements.

The connected tubes of both arise from the part to which they adhere to the rocks, &c. Hence both kinds branch out and swell into irregular lobes; with this difference, that the surface of the sponge is covered with holes guarded with minute points like little spines; the surface of the alcyonium with starry openings of eight rays, whence the polype-like suckers are protruded, to find out proper nourishment: and these starry openings in one, and the holes in the other, so far correspond, that in both kinds they are found of different sizes; but this is in proportion to the age of the branching tubes that come to the surface.

In the sections of the alcyonium may plainly be distinguished the reticulated elastic fibres, that enclose the transparent stiff gelatinous part, as in the sponges; but as this gluey substance is of a firmer texture than what is found in sponges, it requires more pains to separate it from the elastic fibres; however, with a little trouble it may be done sufficiently to evince what he has endeavoured to prove, viz. the great proximity there is between the animal life of sponges and alcyoniums, and, consequently, that both are animals.

Before concluding, he endeavours to remove some doubts, which seem to have distressed the generality of curious persons to account for; the one is, What occasions those very large holes that appear here and there irregularly on the surface of most sponges? the other is, How came those extraneous bodies, such as small shells, stones, and even parts of fucuses, in the middle of these animal bodies? In answer to the first, on cutting open and examining these bodies while recent in sea-water, as before shown, we frequently find a variety of different worms, who bore their way into them, and make their nests and retreats there, or perhaps to live on the gelatinous part of the sponge. But he says, these are not the fabricators, but the inhabitants; and allows the alcyonium to be of animal origin, in which he says he has discovered evident marks of sensation. As to the second doubt, it may be observed by the curious enquirer into nature, that the same property of inclosing extraneous substances is common to the whole class of zoophytes, as they grow up, from the sponge to the red coral.

A

A is an irregular piece of the crumb of bread-sponge, found at Pagham, on the sea-coast of Sussex; a represents the papillæ, through which the sponge receives and dis-

charges the water: this, when recent, is of a fine orange colour.

B is the branched English sponge: along the edges, and on

B

C

the surface of the branches, are rows of small papillary holes, through which the animal receives its nourishment.

C represents the downy-branched English sponge found on the Sussex coast; this is covered over with a fine down so close, that it hides the many small holes that are on its surface.

Description of Mount Sinai. By E. W. MONTAGUE.

AT Suez he found an opportunity of going to Tor by sea, which he gladly embraced, that by going nearer the place at which the Israelites are supposed to have entered the gulf, and having a view from the sea, as well of that as of the opposite shore, he might be a little better able to form a judgment about it. Here it is high water always when the moon is at her meridian height, and it ebbs six hours. At Suez it flows six feet; the spring-tides are nine; and in the variable months, from the beginning of November to the end of April, sometimes 12. From the beginning of May to the beginning of October, a northerly wind generally rises, and goes down with the sun; it is often very strong. This wind never fails in these months, unless there be some violent storm; the rest of the year the winds are variable; and when they blow hard at S. and S.S.E. these winds set up the sea through the narrow strait of Babel Mandel, and up this gulf through its mouth, between Gebel El Zait, on the west side of this sea, and the southermost point of the bay of Tor, on the east side of this western branch of this sea, where it is not above 12 or 14 miles over. Probably such a wind, hindering the water from going out, causes this extraordinary increase in the spring tides. The same thing happens with the same winds at Venice, both gulfs running nearly in the same direction.

The Egyptian, western, or Thebais shore, from Badeah

southward to opposite Tor, on the eastern shore, is all mountainous, and steep; and at Elim, the northernmost point of the bay of Tor, ends the ridge of mountains, which begin on the eastern shore of this western branch at Karondel. The garden of the monks of Mount Sinai at Elim renders in dates, &c. 20,000 piastres per annum, or 2500*l.* Thence they crossed the plain, in about eight hours, and entered the mountains of Sinai. They are of granite of different colours. At the entrance of the narrow breach, through which they passed, he saw, on a large loose granite stone, an inscription in unknown characters, given, he thinks, by Dr. Pocock, Bishop of Ossory; however, as the Israelites had no writing, that we know of, when they passed here, he did not think it of consequence enough to stop for: they arrived at the convent of Mount Sinai, after the usual difficulties mentioned by other travellers, and were received as usual, and saw the usual places. The monks were far from owning that they had ever meddled with the print of the foot of Mahomet's camel. He examined it narrowly, and no chisel has absolutely ever touched it, for the coat of the granite is entire and unbroken in every part; and every body knows, that if the coat of less hard stones than granite be once destroyed, it never returns. It is a most curious lusus naturæ, and the Mahometans turn it to their account. Meribah is indeed surprisingly striking. He examined the lips of its mouths, and found that no chisel had ever worked there: the channel is plainly worn by only the course of water, and the bare inspection of it is sufficient to convince any one it is not the work of man. Among the innumerable cracks in rocks, which he had seen in this, as well as other parts of the world, he never met with any like this, except that at Jerusalem, and the two in the rock which Moses struck twice.

He enquired of the monks, as well as Arabs, about certain places, as well as about some ruins, supposed, by the Bishop of Ossory, to be Kadesh Barnea: the former could only tell him they had not received any fish from thence for many years; that it was two easy days' journey off, but the road was mountainous; so one may suppose the distance less than 40 miles. The Arabs agreed as to the road; but they said, it was once a large place, where their prince lived, whose daughter Moses married; that Moses was afterwards their prince, and the greatest of all prophets. These Arabs place Moses the first, Solomon the second, Mahomet the third, Christ the fourth, and then the prophets of the Bible. As to Dzahab, the monks only knew the distance to be four

days' journey, and that there was a road from it to Jerusalem: the Arabs told him the same, so the distance is about 80 miles. He enquired of them all about the ruins: they told him there were very considerable ones about half way to Dzahab, about 40 miles from Sinai; but he thinks Kadesh must have been much nearer to Jerusalem. He would willingly have gone to these places; but as the four clans of Arabs, which inhabit this promontory, were then at war one with the other, he could get no conductor. However, combining the whole together, and comparing it with what we collect from Scripture, he thinks we may well conclude, Sharme to be Midian, and Meenah El Dzahab to be Eziongeber: what the interjacent ruins are he cannot conjecture; but he believes he had found Kadesh Parnea to be elsewhere. He thinks it cannot be here; for the Israelites were on the borders of the Holy Land, or Land of Promise, when they were ordered back; and when they were stopped by the Moabites, they are said to have been brought up from Kadesh Barnea.

Three Papers, containing Experiments on factitious Air. By the Hon. HENRY CAVENDISH, *F.R.S.*

BY factitious air, says Mr. C., I mean in general any kind of air which is contained in other bodies in an unelastic state, and is produced from thence by art. By fixed air, I mean that particular species of factitious air which is separated from alkaline substances by solution in acids, or by calcination; and to which Dr. Black has given that name in his treatise on quicklime.

On inflammable Air. — I know of only three metallic substances, namely, zinc, iron, and tin, that generate inflammable air by solution in acids; and those only by solution in the diluted vitriolic acid, or spirit of salt. Zinc dissolves with great rapidity in both these acids; and, unless they are very much diluted, generates a considerable heat One ounce of zinc produces about 356 ounce measures of air, the quantity seems just the same whichever of these acids it is dissolved in. Iron dissolves readily in the diluted vitriolic acid, but not near so readily as zinc. One ounce of iron wire produces about 412 ounce measures of air: the quantity was just the same, whether the oil of vitriol was diluted with 1½, or seven times its weight of water; so that the quantity of air produced seems not at all to depend on the strength of the acid.

Tin was found to dissolve scarcely at all in oil of vitriol

diluted with an equal weight of water, while cold; with the assistance of a moderate heat it dissolved slowly, and generated air, which was inflammable; the quantity was not ascertained. Tin dissolves slowly in strong spirit of salt while cold: with the assistance of heat it dissolves moderately fast. One ounce of tin-foil yields 202 ounce measures of inflammable air.

I cannot find that this air has any tendency to lose its elasticity by keeping, or that it is at all absorbed, either by water, or by fixed or volatile alkalies; as I have kept some by me for several weeks in a bottle inverted into a vessel of water, without any sensible decrease of bulk; and as I have also kept some for a few days, in bottles inverted into vessels of soap lees and spirit of sal ammoniac, without perceiving their bulk to be at all diminished.

It has been observed by others, that when a piece of lighted paper is applied to the mouth of a bottle, containing a mixture of inflammable and common air, the air takes fire, and goes off with an explosion. With one part of inflammable air to nine of common air, the mixture would not take fire, on applying the lighted paper to the mouth of the bottle; but on putting it down into the belly of the bottle, the air took fire, but made very little sound. With two parts of inflammable to eight of common air, it took fire immediately, on applying the flame to the mouth of the bottle, and went off with a moderately loud noise. With three parts of inflammable air to seven of common air, there was a very loud noise. With four parts of inflammable to six of common air, the sound seemed very little louder. With equal quantities of inflammable and common air, the sound seemed much the same.

With six parts of inflammable to four of common air, the sound was not very loud: the mixture continued burning a short time in the bottle after the sound was over. With seven parts of inflammable to three of common air, there was a very gentle bounce, or rather puff: it continued burning for some seconds in the belly of the bottle. A mixture of eight parts of inflammable to two of common air caught fire on applying the flame, but without any noise: it continued burning for some time in the neck of the bottle, and then went out, without the flame ever extending into the belly of the bottle. It appears from these experiments, that this air, like other inflammable substances, cannot burn without the assistance of common air.

There seems no reason to imagine, from these experiments, that there is any difference in point of specific gravity between these four sorts of inflammable air. Taking a medium, therefore, of the different trials, 80 ounce measures of inflammable air weigh 41 grains less than an equal bulk of common air. Therefore if the density of common air, at the time when this experiment was tried, was 800 times less than that of water, which, I imagine, must be near the truth, inflammable air must be 5490 times lighter than water, or near seven times lighter than common air But if the density of common air was 850 times less than that of water, then would inflammable air be 9200 times lighter than water, or $10\frac{8}{10}$ lighter than common air.

Experiments on fixed Air. — The air produced, by dissolving marble in spirit of salt, was caught in an inverted bottle of water, in the usual manner. In less than a day's time, much the greatest part of the air was found to be absorbed. The water contained in the inverted bottle was found to precipitate the earth from lime-water; a sure sign that it had absorbed fixed air.

The specific gravity of fixed air was tried by means of a bladder, in the same manner which was made use of for finding the specific gravity of inflammable air; except that the air, instead of being caught in an inverted bottle of water, and thence transferred into the bladder, was thrown into the bladder immediately from the bottle which contained the marble and spirit of salt, by fastening a glass tube to the wooden cap of the bladder, and luting that to the mouth of the bottle containing the effervescing mixture, in such manner as to be air-tight. The bladder was kept on till it was quite full of fixed air: being then taken off and weighed, it was found to lose 31 grains, by forcing out the air. The bladder was previously found to hold 100 ounce measures. Whence if the outward air, at the time when this experiment was tried, be supposed to have been 800 times lighter than water, fixed air is 511 times lighter than water, or $1\frac{57}{100}$ times heavier than common air.

Fixed air has no power of keeping fire alive, as common air has; but, on the contrary, that property of common air is very much diminished by the mixture of a small quantity of fixed air, as appears thus: A small wax candle burnt 80^{s} in a receiver, which held 190 ounce measures, when filled with common air only. The same candle burnt 51^{s} in the same receiver, when filled with a mixture of one part of fixed air to

19 of common air, *i. e.* when the fixed air was $\frac{1}{20}$ of the whole mixture. When the fixed air was $\frac{1}{15}$ of the whole mixture, the candle burnt 23ˢ. When the fixed air was $\frac{1}{10}$ of the whole. it burnt 11ˢ. When the fixed air was $\frac{6}{55}$ or $\frac{1}{9\frac{1}{6}}$ of the whole mixture, the candle went out immediately. Hence it should seem, that when the air contains near one ninth its bulk of fixed air it is unfit for small candles to burn in.

One thousand grains of marble were found to contain $407\frac{1}{2}$ grains of air, and 1661 grains of volatile sal ammoniac contain 885 grains. Therefore this parcel of volatile sal ammoniac contains more fixed air, in proportion to the quantity of acid that it can saturate, than marble does, in the proportion of 885 to $407\frac{1}{2}$, or of 217 to 100.

One thousand five hundred and fifty-eight grains of pearl ashes were found to saturate as much acid as 1000 grains of marble; therefore this parcel of pearl ashes contains more air, in proportion to the quantity of acid that it can saturate, than marble does, in the proportion of 109 to 100.

It was found, by the same method that was made use of for the volatile sal ammoniac, that crystals of salt of tartar contain $\frac{423}{1000}$ of their weight of fixed air, and that 2035 grains of them saturate as much acid as 1000 grains of marble. Therefore these crystals contain more air, in proportion to the quantity of acid they saturate, than marble does, in the ratio of 211 to 100.

Air produced by Fermentation and Putrefaction. — The air produced from brown sugar and water, by fermentation, was caught in an inverted bottle of soap lees in the usual manner. The quantity of sugar put into the bottle was 981 grains: it was dissolved in about $6\frac{1}{2}$ times its weight of water, and mixed with 100 grains of yeast, by way of ferment. The empty space left in the fermenting bottle and tube together measured 1920 grains. The mixture fermented freely, and generated a great deal of air, which was forced up in bubbles into the inverted bottle, but was absorbed by the soap lees, as fast as it rose up. It frothed greatly; but none of the froth or liquor ran over. In about 10 days, the fermentation seeming almost over, the vessels were separated. The bottle with the fermented liquor was found to weigh 412 grains less than it did before the fermentation began. The air remaining unabsorbed in the inverted bottle of soap lees was measured, and was found to be exactly equal to the empty space left in the bent tube and fermenting bottle. It appears,

therefore, that there is not the least air of any kind discharged from the sugar and water by fermentation, but what is absorbed by the soap lees, and which may therefore be reasonably supposed to be fixed air.

The air discharged from apple-juice, by fermentation, was tried exactly in the same manner. The quantity set to ferment was 7060 grains, and was mixed with 100 grains of yeast. Some of the same parcel of apple-juice, being evaporated gently to the consistence of a moderately hard extract, was reduced to one seventh of its weight; so that the quantity of extract, in the 7060 grains of juice employed, was 1009 grains. The liquor fermented much faster than the sugar and water. The loss of weight during the fermentation was 384 grains. The air remaining unabsorbed in the inverted bottle of soap lees was lost by accident; therefore there is no reason to think that the apple-juice, any more than the sugar and water, produced any kind of air during the fermentation, except fixed air.

A small wax candle burnt 15^s in a receiver filled with $\frac{1}{10}$ of air from sugar, the rest common air. In a mixture containing $\frac{6}{55}$ or $\frac{1}{9\frac{1}{6}}$ of air from sugar, the rest common air, the candle went out immediately. When the receiver was filled with common air only, the same candle burnt 72^s.

It appears from these experiments, that the air produced from sugar by fermentation, and in all probability that from all the other sweet juices of vegetables, is of the same kind as that produced from marble by solution in acids, or at least does not differ more from it than the different parts of that air do from each other, and may therefore justly be called fixed air.

The air produced from gravy broth by putrefaction was forced into an inverted bottle of soap lees, in the same way as in the former experiment. The quantity of broth used was 7640 grains, and was found, by evaporating some of the same to the consistence of a dry extract, to contain 163 grains of solid matter. The fermenting bottle was immersed in water, kept constantly to the heat of about 96°. In about two days the fermentation seemed entirely over. The liquor smelt very putrid, and was found to have lost $11\frac{1}{3}$ grains of its weight. The soap lees had acquired a brownish colour from the putrid vapours, and a musty smell. The air forced into the inverted bottle, and not absorbed by the soap lees, measured 6280 grains: the air left in the bent tube and fermenting bottle was 1100 grains. The air was found to be inflamma-

ble; for a small phial being filled with 109 grain measures of it, and 301 of common air, which comes to the same thing as 90 grains of pure factitious air, and 320 of common air, it took fire on applying a piece of lighted paper, and went off with a gentle bounce, of much the same degree of loudness as when the phial was filled with the last-mentioned quantities of inflammable air from zinc, and common air.

On the whole, it seems that this sort of inflammable air is nearly of the same kind as that produced from metals. It should seem, however, either to be not exactly the same, or else to be mixed with some air heavier than it, and which has in some degree the property of extinguishing flame, like fixed air.

Observations on Animals commonly called Amphibious. By Dr. Parsons, F.R.S.

If we consider the term amphibious we should understand that animals, having this title, should be capable of living as well by land or in the air, as by water, or of dwelling in either constantly at will; but it will be difficult to find any animal that can fulfil this definition, as being equally qualified for either; and in classing creatures of this kind, authors are much divided, and sometimes mistaken.

As to the class of the *phocæ*, which consists of a very numerous tribe of different species, he thinks that none of them can live chiefly in the waters, but that their chief enjoyment of the functions of life is on shore. These animals are really quadrupeds; but, as their chief food is fish, they are under a necessity of going out to sea to hunt their prey, and to great distances from shore; taking care that, however great the distance, rocks or small islands are at hand, as resting places when they are tired: and they return to the places of their usual resort, for the following reasons; viz. It is well known that the only essential difference (as to the general structure of the heart) between amphibious and mere land animals or such as never go into the water, is that in the former the oval hole remains always open. Now in such as are without this hole, if they were to be immersed in water for but a little time, respiration would cease, and the animal must die; because a great part of the mass of blood passes from the heart, by the pulmonary artery, through the lungs, and by the pulmonary veins returns to the heart; while the aorta is carrying the greater part of the mass to the head and extremities, &c.

Now the blood passes through the lungs in a continual uninterrupted stream, while respiration is gentle and moderate; but when it is violent, then the circulation is interrupted, for inspiration and expiration are now carried to their extent; and in this state the blood cannot pass through the lungs either during the total inspiration or total expiration of the air in breathing; for in the former case the inflation compresses the returning veins, and in the latter, by the collapsion of the lungs, these veins are interrupted also; so that it is only between these two violent actions that the blood can pass: and hence it is that the lives of animals are shortened, and their health impaired, when they are subjected to frequent violent respiration; and thus it is that in animals who have once breathed, they must continue to respire ever after; for life is at an end when that ceases.

Let us now examine by what power these animals are capable of remaining longer under water than land animals. All these have the oval hole open, between the right and left auricles of the heart, and in many the canalis arteriosus also: and while the phoca remains under water, which he may continue an hour or two more or less, his respiration is stopped, and the blood, not finding the passage through the pulmonary artery free, rushes through the hole from the right to the left auricle, and partly through the arterial canal, being a short passage to the aorta, and thence to every part of the body, maintaining the circulation: but, on rising to come ashore, the blood finds its passage again through the lungs the moment he respires.

Otters, beavers, and some kinds of rats, go occasionally into the water for their prey, but cannot remain very long under water. Dr. P. has seen an otter go softly from a bank into the river, and dive down, and in about two minutes rise, at 10 or 15 yards from the place he went in, with a middling salmon in his mouth, which he brought on shore.

Frogs, how capable soever of remaining in the water, yet cannot avoid living on land, for they respire; and if a frog be thrown into a river, he makes to the shore as fast as he can. The lizard kind, such as may be called water lizards, or lacertæ aquaticæ, are all obliged to come to land and deposit their eggs, to rest, and sleep; even the crocodiles, who dwell much in rivers, sleep and lay their eggs on shore; and, while in the water, are compelled to rise to the surface to breathe; yet, from the texture of his scaly covering, he is capable of remaining in the water longer by far than any species of the phocæ, whose skin is analogous to that of a horse or cow.

The hippopotamus, who wades into the lakes or rivers, is a quadruped, and remains under the water a considerable time; yet his chief residence is on land, and he must come on shore for respiration. The testudo, or sea-tortoise, though he goes out to sea, and is often found far from land, yet, being a respiring animal, cannot remain long under water. He has, indeed, a power of rendering himself specifically heavier or lighter than the water, and therefore can let himself down to avoid an enemy or a storm; yet he is under a necessity of rising frequently to breathe, for reasons given before; and his most usual situation, while at sea, is on the surface of the water, feeding on the various substances that float in great abundance every where about him: these animals sleep securely on the surface, but not under water, and can remain longer at sea than any others of this class, except the crocodile, because, as it is with the latter, his covering is not in danger of being too much macerated.

Let us now examine into the reason why these vermicular fish, the eel and serpent kinds, can live a considerable time on land, and the vertical and horizontal kinds die almost immediately when taken out of the water; and, in this research, we shall come to know what analogy there is between land animals and those of the waters. All land animals have lungs, and can live no longer than while these are inflated by the ambient air, and alternately compressed for its expulsion; that is, while respiration is duly carried on, by a regular inspiration and expiration of air. In like manner, the fish in general have, instead of lungs, gills, or branchiæ; and, as in land animals, the lungs have a large portion of the mass of blood circulating through them, which must be stopped if the air has not a free ingress and egress into and from them; so in fish, there is a great share of blood-vessels that pass through the branchiæ, and a great portion of their blood circulates through them, which must in like manner be totally stopped, if the branchiæ are not kept perpetually wet with water; so that, as the air is to the lungs in land animals, a constant assistant to the circulation, so is the water to the branchiæ of those of the rivers and seas; for when these are out of the water, the branchiæ very soon grow crisp and dry, the blood-vessels are shrunk, and the blood is obstructed in its passage; so, when the former are immersed in water, or otherwise prevented having respiration, the circulation ceases, and the animal dies. Again, as land animals would be destroyed by too much maceration in water, so fishes would, on the other hand, be ruined by too much exsiccation; the latter being, from their

general structure and constitution, made fit to bear, and live in the water; the former, by their constitution and forms, to breathe, and dwell in the air.

Dr. P. mentions something that relates to a family among the fish kinds, which is of a middle nature between the phocæ and the real fishes of the sea, in one peculiar respect. This is the class of the phocenæ, or porpoises, of which there are several species; and these have lungs, and therefore are forced to come up to the surface to breathe at very short intervals; but, when brought on shore, have no progressive loco-motion. So that, having lungs, they resemble the phocæ, and, in every other respect, the real fishes of the sea.

An Account of some peculiar Advantages in the Structure of the Wind-Pipes of several Birds. By Dr. Parsons, F.R.S.

Dr. P. having in the former discourse given an account of some particular phenomena in amphibious animals, which rendered them more happy and perfect in their animal economy towards their preservation, he now lays before the Royal Society certain advantages in some birds, towards assisting them in the acquisition of their food, which they seek for in the water; and some of these swim on the water and dive down occasionally; others only wade into the water, in shallow places, as far as their long legs will carry them, without touching the water with their feathers, in search of their nourishment.

In the general run of birds, the aspera arteria is nearly straight; that is, having no plications, but descending directly from the epiglottis into the cavity of the body, to lie on the sternum, and terminating in the lungs; whereas, in these birds, which are the subjects of this discourse, they have certain turnings within the sternum or breast-bone, and run back again to double up into the thorax; which elongates them to double the length of those in other birds of equal, nay of greater magnitude, than the birds that have them.

In the wild swan, the wind-pipe runs down from its upper extremity under the epiglottis, in company with the œsophagus, till it comes within about four or five inches of the last vertebra of the neck*: here the pipe quits the œsophagus, which keeps its course to the intestines, and makes a convex curve forward between the ossa jugalia, in a circular sweep, till it enters into a hole formed through a strong membrane in the centre between the insertions of the ossa jugalia into the sternum under the breast; and in that circular sweep is covered closely

by the skin, so that, in that place, a very slight blow would destroy the bird. This hole is the beginning of a theca or cavity in the keel of the sternum, in which the pipe passes on to the end, and then returns back, forming a loop which is circular; and, passing out by another hole through the same strong membrane, makes another circular sweep within, and parallel to the exterior one, and then rises in that round direction, till it enters the cavity of the thorax, and is divided into two branchiæ, which terminate in the lungs.

The crane is the next that Dr. P. mentions, which has such a turning of the asperia arteria in the keel of the sternum; but the volution of this bird is round within the bone, and may be compared to that of a French-horn; whereas that of the wild swan is straight within the bone, and may be compared to a trumpet; yet the entrance of this into the sternum, and its exit, and its passage into the cavity of the thorax, are similar to those of the swan. It is somewhat surprising that not one of the tribes which are similar to the crane, such as the herons, storks, bitterns, &c. has any such structure of the asperia arteria, and yet they all feed upon fish or water-insects.

Two Letters from the Hon. William Hamilton, *containing an Account of the last Eruption of Mount Vesuvius. Dated Naples, June* 10. 1766, *and Feb.* 3 1767.

On Good Friday, March 28., at seven o'clock at night, the lava began to boil over the mouth of the volcano, at first in one stream; and soon after dividing itself into two, it took its course towards Portici. It was preceded by a violent explosion, which caused a partial earthquake in the neighbourhood of the mountain, and a shower of red-hot stones and cinders were thrown up to a considerable height. The lava ran near a mile in an hour's time, when the two branches joined in a hollow on the side of the mountain, without proceeding farther. Sir W. approached the mouth of the volcano, as near as he could with prudence: the lava had the appearance of a river of red-hot and liquid metal, such as is seen in the glass-houses, on which were large floating cinders half-lighted, and rolling one over another with great precipitation down the side of the mountain, forming a most beautiful and uncommon cascade; the colour of the fire was much paler and more bright the first night than the subsequent nights, when it became of a deep red, probably owing to its

having been more impregnated with sulphur at first than afterwards. The 29th, the mountain was very quiet, and the lava did not continue. The 30th, it began to flow again in the same direction, while the mouth of the volcano threw up every minute a girandole of red-hot stones, to an immense height. The 31st, he passed the night on the mountain: the lava was not so considerable as the first night, but the red-hot stones were perfectly transparent, some of which, of a ton weight, mounted at least 200 feet perpendicular, and fell in, or near, the mouth of a little mountain, that was now formed by the quantity of ashes and stones, within the great mouth of the volcano, and which made the approach much safer than it had been for some days before, when the mouth was near half a mile in circumference, and the stones took every direction.

It is impossible to describe the beautiful appearance of these girandoles of red-hot stones, far surpassing the most astonishing artificial fire-work. On the 10th of April, at night, the lava disappeared on the side of the mountain towards Naples, and broke out with much more violence on the side next the Torre dell' Annunciata. It burst out of the side of the mountain, within about half a mile of the mouth of the volcano, like a torrent, attended with violent explosions, which threw up inflamed matter to a considerable height, the adjacent ground quivering like the timbers of a water-mill. Notwithstanding the consistency of the lava, it ran with amazing velocity; the first mile with a rapidity equal to that of the river Severn, at the passage near Bristol. The stream at its source was about 10 feet wide, but soon extended itself, and divided into three branches, so that these rivers of fire communicating their heat to the cinders of former lavas, between one branch and the other, had the appearance at night of a continued sheet of fire four miles in length, and in some parts near two in breadth. The glorious appearance of this uncommon scene is such as passes all description.

The lava, after having run pure for about 100 yards, began to collect cinders, stones, &c. and a scum was thus formed on its surface, which in the day-time had the appearance of the river Thames, after a hard frost and great fall of snow, when beginning to thaw, carrying down vast masses of snow and ice. In two places the liquid lava totally disappeared, and ran in a subterraneous passage for some paces, then came out again pure, having left the scum behind. In this manner it advanced to the cultivated parts of the mountain, destroying the cottages in its way. The lava, at the farthest extre-

mity from its source, did not appear liquid, but like a heap of red-hot coals forming a wall, in some places 10 or 12 feet high, which rolling from the top soon formed another wall, and so on, advancing slowly, not more than about 30 feet in an hour.

The mouth of the volcano has not thrown up any large stones since the second eruption of lava, on the 10th of April, but has thrown up quantities of small ashes and pumice stones, that have greatly damaged the neighbouring vineyards. In his last visit to Mount Vesuvius the 2d of June, he still found that the lava continued, but the rivers were become rivulets, and had lost much of their rapidity.

Mount Etna in Sicily broke out on the 27th of April, and made a lava in two branches, at least six miles in length, and a mile in breadth, and that of Vesuvius resembled it in every respect, except that Mount Etna, at the place whence the lava flowed (which was 12 miles from the mouth of the volcano), threw up a fountain of liquid inflamed matter to a considerable height; which, he was told, Mount Vesuvius has done in former eruptions.

Formation of Islands. By ALEX. DALRYMPLE, *Esq.*

THERE is not a part of natural history more curious, or perhaps to a navigator more useful, than an enquiry into the formation of islands. The origin of islands in general is not the point to be discussed; but of low, flat islands in the wide ocean: such as are most of those hitherto discovered in the vast South Sea. These islands are generally long and narrow, they are formed by a narrow bar of land, inclosing the sea within it; generally, perhaps always, with some channel of ingress at least to the tide, commonly with an opening capable of receiving a canoe, and frequently sufficient to admit even larger vessels.

The origin of these islands will explain their nature. What led Mr. D. first to this deduction, was an observation of Abdul Roobin, a Sooloo pilot, that all the islands, lying off the N.E. coast of Borneo, had shoals to the eastward of them. These islands being covered to the westward by Borneo, the winds from that quarter do not attack them with violence.

The N.E. winds, tumbling in the billows from a wide ocean, heap up the coral with which those seas are filled. This, obvious after storms, is perhaps at all other times imperceptibly effected. Coral banks become dry. These

banks are found of all depths, at all distances from shore, entirely unconnected with the land, and detached from each other: though it often happens that they are divided by a narrow gut, without bottom. Coral banks also grow, by a quick progression, towards the surface; but the winds, heaping up the coral from deeper water, chiefly accelerate the formation of these into shoals and islands. They become gradually shallower, and when once the sea meets with resistance, the coral is quickly thrown up by the force of the waves breaking against the bank; and hence it is that, in the open sea, there is scarcely an instance of a coral bank having so little water that a large ship cannot pass over, but it is also so shallow that a boat would ground on it. Mr. D. has seen these coral banks in all the stages; some in deep water, others with a few rocks appearing above the surface, some just formed into islands, without the least appearance of vegetation, and others, from such as have a few weeds on the highest part to those which are covered with large timber, with a bottomless sea at a pistol-shot distance.

The loose coral, rolled inward by the billows in large pieces, will ground, and the reflux being unable to carry them away, they become a bar to coagulate the sand, always found intermixed with coral; which sand, being easiest raised, will be lodged at top. When the sand bank is raised by violent storms, beyond the reach of common waves, it becomes a resting place to vagrant birds, whom the search of prey draws thither. The dung, feathers, &c. increase the soil, and prepare it for the reception of accidental roots, branches, and seed, cast up by the waves, or brought thither by birds. Thus islands are formed: the leaves and rotten branches, intermixing with the sand, form in time a light black mould, of which in general these islands consist, more sandy as less woody; and when full of large trees, with a greater proportion of mould. Cocoa nuts, continuing long in the sea without losing their vegetative powers, are commonly to be found in such islands; particularly as they are adapted to all soils, whether sandy, rich, or rocky.

The violence of the waves, within the tropics, must generally be directed to two points, according to the monsoons. Hence the islands formed from coral banks must be long and narrow, and lie nearly in a meridional direction. For even supposing the banks to be round, as they seldom are when large, the sea, meeting most resistance in the middle, must heave up the matter in greater quantities there than towards the extremities; and, by the same rule, the ends

will generally be open, or at least lowest. They will also commonly have soundings there, as the remains of the banks, not accumulated, will be under water. Where the coral banks are not exposed to the common monsoon, they will alter their direction; and be either round, or extend in the parallel, or be of irregular forms, according to accidental circumstances.

The interior parts of these islands, being sea, sometimes form harbours capable of receiving vessels of some burden, and he believes always abound greatly with fish; and such as he has seen, with turtle-grass and other sea-plants, particularly one species, called by the Sooloos gammye, which grows in little globules, and is somewhat pungent as well as acid to the taste. It need not be repeated, that the ends of those islands only are the places to expect soundings; and they commonly have a shallow spit running out from each point. Abdul Roobin's observation points out another circumstance, which may be useful to navigators; by consideration of the winds to which any islands are most exposed, to form a probable conjecture which side has deepest water; and from a view which side has the shoals, an idea may be formed which winds rage with most violence.

On the Eruption of Mount Vesuvius, in 1767. By the Hon. William Hamilton. Dated Naples, Dec. 29. 1767.

The late violent eruption began October 19. 1767, and is reckoned to be the 27th since that which, in the time of Titus, destroyed Herculaneum and Pompeii. The eruption of 1766 continued in some degree till the 10th of December, about nine months in all, yet in that space of time the mountain did not cast up a third part so much as the quantity of lava which it disgorged in only seven days, the term of this last eruption.

The lava continued to run over the ancient crater in small streams, sometimes on one side, and sometimes on another, till the 18th of October, when there was not the least lava to be seen, owing, probably, to its being employed in forcing its way towards the place where it burst out the following day. Sir W. was surprised on the 19th following, at seven in the morning, to perceive every symptom of the eruption being just at hand. From the top of the little mountain issued a thick black smoke, so thick that it seemed to have difficulty in forcing its way out; cloud after cloud mounted with a hasty spiral motion, and every minute a volley of great stones were shot up to an immense height in the midst

of these clouds; by degrees, the smoke took the exact shape of a huge pine-tree, such as Pliny the younger described in his letter to Tacitus, where he gives an account of the fatal eruption in which his uncle perished. This column of black smoke, after having mounted an extraordinary height, bent with the wind towards Caprea, and actually reached over that island, which is not less than 28 miles from Vesuvius.

Before eight in the morning, the mountain had opened a mouth, without noise, about 100 yards lower than the ancient crater, on the side towards the Monte di Somma: as soon as it had vent, the smoke no longer came out with that violence from the top. On a sudden, about noon, Sir W. heard a violent noise within the mountain, which split; and, with much noise, from this new mouth a fountain of liquid fire shot up many feet high, and then like a torrent rolled on directly towards him. The earth shook, at the same time that a volley of pumice stones fell thick upon him; in an instant, clouds of black smoke and ashes caused almost a total darkness; the explosions from the top of the mountain were much louder than any thunder he ever heard, and the smell of the sulphur was very offensive. About two in the afternoon another stream of lava forced its way out of the same place as the lava came last year, so that the conflagration was soon as great on one side of the mountain as on the other.

The noise and smell of sulphur increasing, Sir W. removed from his villa to Naples; and he thought proper, as he passed by Portici, to inform the court of what he had seen; and humbly offered it as his opinion, that his Sicilian Majesty should leave the neighbourhood of the threatening mountain. However, the court did not leave Portici till about 12 o'clock. Sir W. observed, in his way to Naples, which was in less than two hours after he had left the mountain, that the lava had actually covered three miles of the very road through which he had retreated. It is astonishing that it should have run so fast; as he afterwards saw that the river of lava, in the Arrio di Cavallo, was 60 and 70 feet deep, and in some places near two miles broad. When his Sicilian Majesty quitted Portici, the noise was greatly increased, and the confusion of the air from the explosions was so violent, that, in the King's palace, doors and windows were forced open, and even one door there, which was locked, was burst open. At Naples, the same night, many windows and doors flew open. Besides the explosions, which were very frequent, there was a continued subterraneous and violent rumbling noise, which lasted this night about five hours. Sir W. imagined that this extra-

ordinary noise might be owing to the lava in the bowels of the mountain having met with a deposition of rain-water, and that the conflict between the fire and the water may, in some measure, account for so extraordinary a crackling and hissing noise. In the great eruption of Mount Vesuvius in 1663, it is well attested, that several towns, among which Portici and Torre del Greco, were destroyed by a torrent of boiling water having burst out of the mountain with the lava, by which thousands of lives were lost. About four years ago, Mount Etna, in Sicily, threw up hot water also, during an eruption.

Tuesday the 20th, it was impossible to judge of the situation of Vesuvius, on account of the smoke and ashes which covered it entirely, and spread over Naples also, the sun appearing as through a thick London fog, or a smoked glass: small ashes fell all this day at Naples. The lavas on both sides of the mountain ran violently; but there was little or no noise till about nine o'clock at night, when the same uncommon rumbling began again, accompanied with explosions as before, which lasted about four hours; it seemed as if the mountain would split in pieces; and indeed it opened this night by a large orifice. Wednesday the 21st was more quiet than the preceding days, though the lavas ran briskly. Portici was once in some danger, had not the lava taken a different course, when it was only a mile and a half from it: towards night the lava slackened.

Thursday 22d, about ten in the morning the same thundering noise began again, but with more violence than the preceding days. The ashes, or rather small cinders, showered down so fast, that the people in the streets were obliged to use umbrellas, or flap their hats, these ashes being very offensive to the eyes. The tops of the houses, and the balconies, were covered above an inch thick with these cinders. Ships at sea, 20 leagues from Naples, were also covered with them, to the great astonishment of the sailors.

Friday 23d, the lavas still ran, and the mountain continued to throw up quantities of stones from its crater: there was no noise heard at Naples this day, and but little ashes fell there.

Saturday 24th, the lava ceased running: the extent of the lava, from the spot where it broke out to its extremity where it surrounded the chapel of Saint Vito, is above six miles. In the Atrio di Cavallo, and in a deep valley, that lies between Vesuvius and the hermitage, the lava is in some places near two miles broad, and in most places from 60 to 70 feet deep. The lava ran down a hollow way, called Fossa Grande, made by the currents of rain-water: it is not less than 200 feet

deep, and 100 broad; yet the lava in one place has filled it up. On this day Vesuvius continued to throw up stones as on the preceding days; during the whole of this eruption it had differed in this circumstance from the eruption of 1776, when no stones were thrown out of the crater from the moment the lava ran freely.

Observations on the Bones found near the River Ohio, in America. By William Hunter, *M. D. F R. S.*

Naturalists, even those of our own times, have entertained very different opinions concerning fossil ivory, and the large teeth and bones, which have been dug up in great numbers in various parts of the world. At first, some thought them animal substances, and others mineral. When only a certain number of observations had been collected, these substances were determined to be mineral; but, the subject having been more carefully examined, they were found certainly to be parts of animals.

We had information from Muscovy, that the inhabitants of Siberia believed them to be the bones of the mammoth, an animal of which they told and believed strange stories. But modern philosophers have held the mammoth to be as fabulous as the centaur. Of late years the same sort of tusks and teeth, with some other large bones, have been found in considerable numbers, near the banks of the Ohio, in North America.

From the first time that Dr. H. learned this part of natural knowledge, it appeared to him to be very curious and interesting; inasmuch as it seemed to concur with many other phenomena, in proving that in former times some astonishing change must have happened to this terraqueous globe; that the highest mountains, in most countries now known, must have lain for many ages in the bottom of the sea; and that this earth must have been so changed with respect to climates, that countries which are now intensely cold must have been formerly inhabited by animals which are now confined to the warm climates.

Some time in the last spring, having been informed that a considerable quantity of elephants' teeth had been brought to the Tower, from America, Dr. H. went to the Tower, and examined the whole collection which had been sent over from the Ohio: he saw that the grinders were all of the same kind. He examined two elephants' jaws in his brother's collection: he examined the tusks and grinders of the Queen's two elephants; and he examined a great number of African

elephants' teeth at a warehouse. From all these observations, Dr. H. was convinced that the grinder-tooth, brought from the Ohio, was not that of an elephant, but of some carnivorous animal, larger than an ordinary elephant; and he could not doubt that the tusk belonged to the same animal. The only difference that he could observe between it and a real elephant's tusk was, that it was more twisted, or had more of the spiral curve, than any of the elephants' teeth which he had seen.

Dr. H. afterwards examined, also, several more of the tusks and grinders that had been sent from the Ohio to Dr. Franklin and to Lord Shelburne; and, on the whole, he was now fully convinced, that the supposed American elephant was an animal of another species, a pseudo-elephant, or animal incognitum, which naturalists were unacquainted with. He imagined, further, that this animal incognitum would prove to be the supposed elephant of Siberia, and other parts of Europe; and that the real elephant would be found to have been in all ages a native of Asia and Africa only.

Of several Phenomena observed during the Ingress of Venus into the Solar Disk, in 1769. *By the Rev. W. Hirst, F.R.S.*

The telescope Mr. H. used was a reflector two feet in length, and magnified 55 times Expecting the planet to enter the solar disk at or near the zenith, he kept his eye constantly fixed at that part of the sun a considerable time before the beginning of the transit. The first intimation which he had of the near approach of the planet, was by the sudden appearance of a violent coruscation, ebullition, or agitation of the upper edge of the sun. Mr. H. had not made this observation above five or six seconds, when he plainly saw a black notch breaking in upon the sun's limb, and which seemed a portion of a much less sphere than that of Venus.

The same phenomenon of a protuberance, which Mr. H. observed at Madras, in 1761, at both internal contacts, he observed again at this last transit: at both times, the protuberance of the upper edge of Venus diminished nearly to a point before the thread of light between the concave edge of the sun and the convex edge was perfected, when the protuberance instantaneously broke off from the upper edge of the sun, but Venus did not assume its circular form till it had descended into the solar disk, at least to the distance, by estimation, from the upper edge of the sun.

In the transit of this present year, he did not take notice of the same phenomenon as he did of the transit of Venus, in India, in the year 1761; but he here again insists on it, that such penumbra or dusky shade he then actually saw; but he did not recollect that he then saw the least undulation, ebullition, or coruscation, as happened in the transit of this present year. Yet both phenomena were conducive to the same purpose, and served to give him notice of the near approach of the planet Venus, to the solar disk, the event, in both instances, justifying the presage; and both appearances might be the consequences of the same cause; which cause might be nothing less than the atmosphere of Venus.

A Journey to Mount Etna. By the Hon. WILLIAM HAMILTON.

AFTER having examined, with much attention, the operations of Mount Vesuvius, during five years, and after having carefully remarked the nature of the soil for 15 miles round Naples, Sir W. was well convinced that the whole of it has been formed by volcanic eruptions.

On the 24th of June, 1760. Sir W. and two companions left Catania, a town situated at the foot of Mount Etna, and passed through the inferior district of the mountain, called by its inhabitants La Regione Pieniontese. It is well watered, exceedingly fertile, and abounding with vines, and other fruit-trees, where the lava, or, as it is called there, the Sciara, has had time to soften and gather soil sufficient for vegetation, which he was convinced from many observations, unless assisted by art, does not come to pass for many ages, perhaps a thousand years or more.

After about four hours of gradual ascent they arrived at a little convent of Benedictine monks, called St. Nicolo dell' Arena, about 13 miles from Catania, and within a mile of the volcano, whence issued the last very great eruption, in the year 1669. The lava that ran from it, and on which there are as yet no signs of vegetation, is 14 miles in length, and in many parts six in breadth. There has been no such eruption since, though there are signs of many, more terrible, that have preceded it.

If the dates of these explosions could be ascertained, it would be very curious, and mark the progress of time with respect to the return of vegetation, as the mountains raised by them are in different states; those which seem to be the most modern are covered with ashes only; others, of an older

date, with small plants and herbs; and the most ancient, with the largest timber-trees he ever saw; but he believes the latter are so very ancient, as to be far out of the reach of history. On every side are mountains, or fragments of mountains, that have been thrown up by various ancient explosions: some are near as high as Mount Vesuvius, one, in particular, is little less than one mile in perpendicular height, and five in circumference at its basis. They are all more or less covered, even within their craters, as well as the rich valleys between them, with the largest oak, chesnut, and fir trees, he ever saw any where; and, indeed it is hence, chiefly, that his Sicilian Majesty's dock-yards are supplied with timber. As this part of Etna was famous for its timber in the time of the tyrants of Syracuse, and as it requires the great length of time already mentioned, before the matter is fit for vegetation, we may conceive the great age of this volcano.

At one o'clock in the morning of the 26th, they pursued their journey towards the great crater. They passed over valleys of snow that never melts, except there is an eruption of lava from the upper crater, which scarcely ever happens: the great eruptions are usually from the middle region, the inflamed matter finding, probably, its passage through some weak part, long before it can rise to the excessive height of the upper region, the great mouth on the summit only serving as a common chimney to the volcano. This mountain is situated in a gently inclining plain, of about nine miles in circumference; it is about a quarter of a mile perpendicular in height, and very steep. — The steep ascent, the keenness of the air, the vapours of the sulphur, and the violence of the wind, which obliged them several times to throw themselves flat on their faces to avoid being overturned by it, made this latter part of the expedition rather inconvenient and disagreeable.

Soon after they had seated themselves on the highest point of Etna, the sun arose, and displayed a scene that indeed passes all description. They took in at one view a circle of about 900 English miles. They counted from hence 44 little mountains, (little in comparison of their mother Etna, though they would appear great any where else,) in the middle region on the Catania side, and many others on the other side of the mountain, all of a conical form, and each having its crater; many with timber-trees flourishing both within and without their craters. The points of those mountains, that he imagined to be the most ancient, are blunted, and the craters of course more extensive and less deep than those of the mountains formed by explosions of a later date, and which

preserve their pyramidal form entire. Some have been so far mouldered down by time as to have no other appearance of a crater than a sort of dimple or hollow on their rounded tops, others with only a half or a third part of their cone standing; the parts that are wanting having mouldered down, or perhaps been detached from them by earthquakes, which are here very frequent. All, however, have been evidently raised by explosion; and he believes, on examination, many of the whimsical shapes of mountains in other parts of the world would prove to have been occasioned by the same natural operations.

They looked into the great crater, which is about two miles and a half in circumference: they did not think it safe to go round and measure it, as some parts seemed to be very tender ground. The inside of the crater, which is incrusted with salts and sulphurs like that of Vesuvius, is in the form of an inverted hollow cone, and its depth nearly answers to the height of the little mountain that crowns the great volcano. The smoke, issuing abundantly from the sides and bottom, prevented their seeing quite down; but the wind clearing away the smoke from time to time, they saw this inverted cone contracted almost to a point.

As the lavas of Etna are very commonly 15 and 20 miles in length, six or seven in breadth, and 50 feet or more in depth, we may judge of the prodigious quantities of matter emitted in a great eruption of this mountain, and of the vast cavities there must necessarily be within its bowels.

He found, with respect to the matter erupted, nothing on Mount Etna that Vesuvius does not produce; and there certainly is a much greater variety in the erupted matter and lavas of the latter than of the former: both abound with pyrites and crystallisations, or rather vitrifications. The sea-shore at the foot of Etna, indeed, abounds with amber, of which there is none found at the foot of Vesuvius.

Account of a very remarkable young Musician. By the Hon. DAINES BARRINGTON, *F.R.S.*

J. C. W. T. MOZART, was born at Saltzbourg, in Bavaria, on the 17th of Jan. 1756. Mr B. was informed, by a most able musician and composer, that he frequently saw him at Vienna, when he was little more than four years old. By this time he not only was capable of executing lessons on his favourite instrument, the harpsichord, but composed some in an easy style and taste, which were much approved of. His extra-

ordinary musical talents soon reached the ears of the Empress-dowager, who used to place him on her knees while he played on the harpsichord.

He came over to England* in 1764, where he continued more than a year; and during this time Mr. B. witnessed his extraordinary abilities as a musician, both at some public concerts, and by having been alone with him for a considerable time at his father's house. He carried to him a manuscript duet, which was composed by an English gentleman to some favourite words of Metastasio. The whole score was in five parts, viz. accompaniments for a first and second violin, the two vocal parts, and a base. Mr. B.'s intention, in carrying with him this manuscript-composition, was to have an irrefragable proof of his abilities, as a player at sight, it being absolutely impossible that he could have ever seen the music before. The score was no sooner put upon his desk than he began to play the symphony in a most masterly manner, as well as in the time and style which corresponded with the intention of the composer. The symphony ended, he took the upper part, leaving the under one to his father. His voice in the tone of it was thin and infantine, but nothing could exceed the masterly manner in which he sung. His father, who took the under part in this duet, was once or twice out, though the passages were not more difficult than those in the upper one; on which occasion the son looked back with some anger, pointing out to him his mistakes, and setting him right. He not only, however, did complete justice to the duet, by singing his own part in the truest taste, and with the greatest precision; he also threw in the accompaniments of the two violins, wherever they were most necessary, and produced the best effects. It is well known that none but the most capital musicians are capable of accompanying in this superior style.

Happening to know that little Mozart was much taken notice of by Manzoli, the famous singer, who came over to England in 1764, Mr. B. said to the boy, that he should be glad to hear an extempore love-song, such as his friend Manzoli might choose in an opera. The boy on this, who continued to sit at his harpsichord, looked back with much archness, and immediately began five or six lines of a jargon recitative proper to introduce a love-song. He then played a symphony which might correspond with an air composed to the single word Affetto. It had a first and second part, which, together with the symphonies, was of the length that opera-songs generally are.

Finding that he was in humour, and as it were inspired, Mr. B. then desired him to compose a song of rage, such as might be proper for the opera-stage. The boy again looked back with much archness, and began five or six lines of a jargon recitative proper to precede a song of anger. This lasted also about the same time with the song of love; and in the middle of it, he had worked himself up to such a pitch, that he beat his harpsichord like a person possessed, rising sometimes in his chair. The word he pitched on for this second extemporary composition was Perfido.

After this he played a difficult lesson, which he had finished a day or two before: his execution was amazing, considering that his little fingers could scarcely reach a fifth on the harpsichord. His astonishing readiness, however, did not arise merely from great practice; he had a thorough knowledge of the fundamental principles of composition, as, on producing a treble, he immediately wrote a base under it, which, when tried, had a very good effect.

Mr. B. made frequent enquiries with regard to this very extraordinary genius after he left England, and was told, in 1769, that he was then at Saltzbourg, where he had composed several oratorios, which were much admired. He was also informed, that the Prince of Saltzbourg, not crediting that such masterly compositions were really those of a child, shut him up for a week, during which he was not permitted to see any one, and was left only with music-paper, and the words of an oratorio. During this short time he composed a very capital oratorio, which was most highly approved, on being performed.

Having stated these proofs of Mozart's genius, when of almost an infantine age, it may not be improper, perhaps, to compare them with what has been well attested, with regard to other instances of the same sort. Among these, John Barratier has been most particularly distinguished, who is said to have understood Latin when he was but four years old, Hebrew when six, and three other languages at the age of nine. This same prodigy of philological learning also translated the travels of Rabbi Benjamin when 11 years old, accompanying his version with notes and dissertations. Before his death, which happened under the age of 20, Barratier seems to have astonished Germany with his amazing extent of learning.

The Rev. Mr. Manwaring, in his Memoirs of Handel, has given us a still more apposite instance, and in the same science. This great musician began to play on the clavichord

when he was but seven years of age, and is said to have composed some church-services when he was only nine years old, as also the opera of Almeria, when he did not exceed 14.

Journal of a Voyage, made by Order of the Royal Society, to Churchill River, on the North-west Coast of Hudson's Bay; of Thirteen Months' Residence in that Country; and of the Voyage back to England; in 1768 *and* 1769. *By* WM. WALES.

THIS sea-journal is now very uninteresting. The party sailed from the river, May 31. 1768; and July 23. arrived at the island of Resolution, which forms the north shore at the entrance of Hudson's Straits, where the variation of the needle was found 39° 48′ west.

On the 8th of Aug. they arrived at the factory in Churchill River, their desired station. The soil consists entirely of high bare rocks, or loose gravel; among the latter, there shoots up, in the lower places, many dwarf-willows, and birch; in the higher ones some small gooseberry-bushes; but these do not grow upright as in England, but creep along the gravel like the bramble-brier. They saw, besides these, some strawberries, many cranberries, and a few bilberries; but none of these were yet ripe, except a few of the last. They also saw some few plants creeping among the moss; but none that they knew, except the dandelion and small yarrow.

Mr. W. found here three very troublesome insects. The first is the mosquito, too common in all parts of America, and too well known to need describing here. The second is a very small fly, called (he supposes on account of its smallness) the sand-fly. These, in a hot calm day, are intolerably troublesome: there are continually millions of them about one's face and eyes, so that it is impossible either to speak, breathe, or look, without having one's mouth, nose, or eyes full of them. One comfortable circumstance is, that the least breath of wind disperses them in an instant. The third insect is much like the large flesh-fly in England; but at least three times as large: these, on whatever part they fix their teeth, are sure to carry a piece away with them, an instance of which he had frequently seen and experienced.

The 16th, Mr. W. went with Mr. Fowler about 10 miles up the country, which, as far as they went, was nothing but banks of loose gravel, bare rocks, or marshes, which are overflowed by the spring-tides, and do not get dry before they return and overflow them again. Their errand was, to

see if they could not find some sand likely to produce corn; and in all that extent they did not find one acre, which was likely to do it. In some of the marshes the grass is very long, and with much labour they cut and dry as much hay as keeps three horses, two cows, a bull, and two or three goats, the whole winter. He saw many acres of land covered with fir-trees, some of which might be perhaps about 20 feet high: these grow chiefly on the borders of the marsh-lands, or, which is the same thing, round the skirts of the rocky parts.

November the 6th, the river, which is very rapid, and about a mile over at its mouth, was frozen fast over from side to side, so that the people walked across it to their tents: also the same morning, a half-pint glass of British brandy was frozen solid in the observatory. Not a bird of any kind was now to be seen at the factory, except now and then a solitary crow, or a very small bird about the size of a wren.

In January, 1769, the cold began to be extremely intense: even in their little cabin, which was scarcely three yards square, and in which they constantly kept a very large fire, it had such an effect, that the little alarm-clock would not go without an additional weight, and often not with that. The head of Mr. W.'s bed-place, for want of knowing better, went against one of the outside walls of the house; and though they were of stone, near three feet thick, and lined with inch boards, supported at least three inches from the walls, the bedding was frozen to the boards every morning; and before the end of February, these boards were covered with ice almost half as thick as themselves. Towards the latter end of January, when the cold was so very intense, he carried a half-pint of brandy, perfectly fluid, into the open air, and in less than two minutes it was as thick as treacle; in about five, it had a very strong ice on the top.

It was now almost impossible to sleep an hour together, more especially on very cold nights, without being awakened by the cracking of the beams in the house, which were rent by the prodigious expansive power of the frost. It was very easy to mistake them for the guns on the top of the house, which are three-pounders. But those are nothing to what we frequently hear from the rocks up the country, and along the coast; these often bursting with a report equal to that of many heavy artillery fired together, and the splinters are thrown to an amazing distance.

March 19th, it thawed in the sun, for the first time, and on the 26th it thawed in reality. The yard of the factory

was that day almost covered with water After this, it continued to thaw every day about noon when the sun was out: and by the 23d of April the ground was in many places bare. On the 26th it rained very fast, almost the whole night, which was the first rain after October the 3d, 1768.

During most of the winter months, November, December, January, February, and March, the thermometer without was considerably below zero, the lowest of all being — 45, that is, 15 below 0, which was on the 22d of January. And the highest state was + 80, viz. on the 3d of July.

Observations on the Aphides of Linnæus. By Dr. WILLIAM RICHARDSON, *of Ripon, Yorkshire.*

THOUGH the aphides are distinguished by Linnæus into more than 30 species, still Dr. R. is satisfied, from his own observation, that the distinct species are even double that number: nor can he altogether agree with this ingenious author, that there are a greater variety of plants producing aphides than there are different sorts of this insect. Where plants are of a like nature, they are usually frequented by the same insects; but many of these plants will be found to support two or more quite different sorts. On the peach and nectarine, indeed, the aphides are the same, and he did not find on these trees more than one sort. The plum-tree, on the other hand, has two sorts, very distinct from each other; one of a yellowish green, with a round short body; the other of a bluish green, as it were enamelled with white, and the shape more oblong. On the gooseberry-bush and currant the same aphides may be found; but each of these is inhabited by two very different species; one being of a dusky green, with a short plump body; the other of a paler green, the body more taper, and transversely wrinkled. To these instances he further adds, that the rose-tree supports not less than three distinct species; the largest of which is of a deep green, having long legs of a brownish cast, with the joints of a very dark brown, as are also the horns and antennæ; a second sort is paler green, has much shorter legs, and a more flat body; the third sort is of a pale red, its body transversely wrinkled, and is most frequently on the sweetbriar.

If, at the beginning of February, the weather happens to be so warm, as to make the buds of the rose-tree swell and appear green, small aphides are frequently to be found upon them, not larger than the young ones in summer, when first

produced. But there being no old ones to be found at this time of the year, which in summer he had observed to be viviparous, he was formerly not a little perplexed by such different appearances, and was almost induced to give credit to the old doctrine of equivocal generation

Those which withstand the severity of the weather seldom come to their full growth before the month of April; at which time they usually begin to breed, after twice casting off their exuviæ, or outer covering. It then appears that that they are all females, which produce each of them a very numerous progeny. As before observed, they are viviparous; and what is equally uncommon, the young ones all come into the world backwards. When they first come from the parent, they are enveloped by a thin membrane, having in this situation the appearance of an oval egg; which probably induced Reaumur to suspect that the eggs discovered by Bonnet were nothing more than abortions. This egg-like appearance adheres by one extremity to the mother, while the young one contained extends the other; by that means gradually drawing the ruptured membrane, over the head and body, to the hind feet. During this operation, and for some time after, by means of something glutinous, the fore part of the head adheres to the vent of the parent. Being thus suspended in the air, it soon frees itself from the membrane in which it was confined; and after its limbs are a little strengthened, is set down on some tender shoot, and then left to provide for itself. When the spring proves mild, and consequently favourable to this kind of insect, Dr. R. has observed not only the rose-trees, but various kinds of fruit-trees, to be greatly injured by them.

In the spring months, there appear on the rose-tree only two generations of aphides, including those which immediately proceed from the last year's eggs: the warmth of the summer adds so much to their fertility, that no less than five generations succeed each other during that interval. One is produced in May, which twice casts off its covering; while the months of June and July each supply two more, which cast off their coverings three or four times, according to the different warmth of the season. This frequent change of the outer covering is the more extraordinary, as it is the oftenest repeated when the insects come the soonest to their growth; which Dr. R. has sometimes observed to happen in ten days, where warmth and plenty of nourishment have mutually conspired.

Early in the month of June, some of the third generation,

which were produced about the middle of May, after casting off their last covering, discover four erect wings, much longer than their bodies; and the same is observable in all the succeeding generations, which are produced during the summer months, without, however, distinguishing any diversity of sex, as is usual in several other kinds of insects. For some time before the aphides come to their full growth, it is easy to discover which of them will have wings, by a remarkable fulness in the breast, which in the others is hardly to be distinguished from the body. When the last covering is rejected, the wings, which were before folded up in a very narrow compass, gradually extend themselves in a most surprising manner, till their dimensions are at last very considerable.

A very small black ichneumon fly, with a slender body, and very long antennæ, darts its pointed tail into the bodies of the aphides, at the same time depositing an egg in each. This egg produces a worm, which feeds on the containing insect, till it has acquired its full growth; when it is usually changed to that kind of fly from which it had its origin. In this, however, it is sometimes prevented by another sort of small black fly, which wounds this worm through its pearl-like habitation; and by laying one of its eggs in it, instead of the former fly, produces its own likeness.

In the autumn, Dr. R. finds three more generations of aphides to be produced; two of which make their appearance in the month of August, and the third usually before the middle of September. As the first two differ in no respect from those which are met with in summer, it would be wasting time to dwell any longer on them; but the third, differing greatly from all the rest, demands our giving it a more serious attention. Though all the aphides which have hitherto appeared were females, in this tenth generation are found several male insects; not that they are by any means so numerous as the females, being only produced by a small part of the former generation. To which Dr. R. further adds, that he has observed those which produce males previously to have produced a number of females, which in all respects resemble those already described.

The females have at first altogether the same appearance with those of the former generations; but in a few days their colour changes from a green to a yellow, which is gradually converted into an orange-colour, before they come to their full growth. They differ likewise in another respect, at least from those which occur in the summer, that all those yellow

females are without wings. The male insects are, however, still more remarkable, their outward appearance readily distinguishing them from the females, of this and all other generations. When first produced they are not of a green colour, like the rest, but of a reddish brown; and have afterwards, when they begin to thicken about the breast, a dark line along the middle of the back. These male insects come to their full growth in about three weeks' time, and then cast off their last covering; the whole insect being after this operation of a bright yellow, the wings only excepted. But they soon change to a darker yellow, and in a few hours to a very dark brown; if we except the body, which is something lighter coloured, and has a reddish cast. They are all of the winged sort; and the wings, which are white at first, soon become transparent, and at length appear like very fine black gauze.

Though Dr. R. has observed that the contents of the eggs have the appearance of a uniform fluid; that this cannot in reality be the case, sufficiently appears from the aphides they produce in the spring, without any other aid than the warmth of the season. Nor is a single insect to be esteemed the whole product of an egg, since it has been clearly shown, that ten generations succeed each other; the first rudiments of which must have been originally in the egg. The wonder however becomes still greater, when we consider the number of individuals in each generation; this being, he is fully convinced, at a medium, not less than 50. Whoever pleases to multiply by 50, nine times over, may by this means form some notion of the great number of insects produced from a single egg; but will at the same time find that number so immense, as to exceed all comprehension, and indeed to be little short of infinity.

Astronomical Observations made, by Appointment of the Royal Society, at King George's Island in the South Sea. By Mr. CHARLES GREEN *and Lieutenant* JAMES COOK.

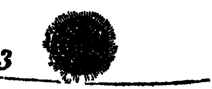
THE first appearance of Venus on the sun was certainly only th[illegible]penumbra, and the contact of the limbs did not hap[illegible]ll several seconds after, and then it appeared as in [illegible] This appearance was observed both by Mr. Green an[illegible] but the time it happened was not noted by either of [illegible]: 'it appeared to be very difficult to judge precisely of the times that the internal contacts of the body of Venus happened, by reason of the darkness of the penumbra at the

sun's limb, it being there nearly, if not quite, as dark as the planet.

At this time a faint light, much weaker than the rest of the penumbra, appeared to converge towards the point of contact, but did not quite reach it: see fig. 2. This was seen by myself and the two other observers, and was of great assistance to us in judging of the time of the internal contacts of the dark body of Venus, with the sun's limb.

1

2

3


The first internal contact, or the limb of Venus, seemed to coincide with the sun's, as represented by fig. 3.

The Quantity of the Sun's Parallax, as deduced from the Observations of the Transit of Venus, June 3. 1769. By THOMAS HORNSBY, *M.A. F.R.S.*

THE uncertainty as to the quantity of the sun's parallax, deduced from the observations of the transit of Venus in 1761, (whether it arose from the unfavourable position of the planet, so that a sufficient difference of time in the total duration of the transit was not, and indeed could not be, obtained from observations made at different places; or from the disagreement of the observations of different astronomers, which were to serve as terms of comparison,) seems now to be entirely removed; and from the observations made in distant parts by the astronomers of different nations, and especially from those made under the patronage and direction of this society, the learned of the present time may congratulate themselves on obtaining as accurate a determination of the sun's distance as perhaps the nature of the subject will admit.

The parallax on the third of June being 8''.65, the mean parallax will be found to be = 8''.78; and if the semidiameter of the earth be supposed = 3985 English miles, the mean distance of the earth from the sun will be 93,726,900 English miles.

Observations on Vegetation. By Mr. MUSTEL *of Rouen.*

MANY celebrated writers, induced by the analogy which they observed between the vegetable and animal kingdoms, have admitted the circulation of the sap in the one, in a similar manner to the circulation of the blood in the other.

On the 12th of January, Mr. Mustel placed several shrubs in pots against the windows of his hot-house, some within the house, and others without it. Through holes made for this purpose in the panes of glass, he passed a branch of each of the shrubs, so that those on the inside had a branch without, and those on the outside one within; after this, he took care that the holes should be exactly closed and luted.

The 20th of January, a week after this disposition, all the branches that were in the hot-house began to disclose their buds. In the beginning of February there appeared leaves, and towards the end of it shoots of a considerable length, which presented the young flowers. A dwarf apple-tree and several rose-trees, being submitted to the same experiment, showed the same appearance then as they commonly put on in May; in short, all the branches which were within the hot-house, and consequently kept in the warm air, were green at the end of February, and had their shoots in great forwardness. Very different were those parts of the same tree which were without, and exposed to the cold. None of these gave the least sign of vegetation; and the frost, which was intense at that time, broke a rose-pot placed on the outside, and killed some of the branches of that very tree, which on the inside was every day putting forth more and more shoots, leaves, and buds, so that it was in full vegetation on one side, while frozen on the other.

The continuance of the frost occasioned no change in any of the internal branches. They all continued in a very brisk and verdant state, as if they did not belong to the tree, which, on the outside, appeared in a state of the greatest suffering. On the 15th of March, notwithstanding the severity of the season, all was in full bloom. The apple-tree had its root, its stem, and part of its branches, in the hot-house. These branches were covered with leaves and flowers; but the branches of the same tree, which were carried to the outside, and exposed to the cold air, did not in the least partake of the activity of the rest, but were absolutely in the same state which all trees are in during winter. A rose-tree, in the same position, showed long shoots with leaves and buds; it had even shot a vigorous branch on its stalk, while a branch which passed through to the outside had not begun to produce any thing, but was in the same state with other rose-trees left in the ground.

The interior branches continued their productions in a regular manner, and the external ones began theirs at the same time, and in the same manner, as they would have done

had they been left in the ground. The fruits of the interior branches of the apple-tree were, in the beginning of May, of the size of nutmegs; while the blossoms but just began to show themselves on the branches without.

The consequences seemed to prove, 1. That the circulation of the sap does not take place in plants as the circulation of the blood in animals. 2. That each part of a tree is furnished with a sufficient quantity of sap to effect the first production of buds, flowers, and fruits. 3. That it is heat which unfolds the leaves, and produces the other parts of fructification, in the branch exposed to its action. From this it appears, that the vegetable economy is different from the animal, and that those who endeavoured to establish the circulation in both carried their analogy too far.

Experiments and Observations on the Singing of Birds. By the Hon. Daines Barrington, *V.P. R.S.*

To chirp is the first sound which a young bird utters, as a cry for food, and is different in all nestlings, if accurately attended to; so that the hearer may distinguish of what species the birds are, though the nest may hang out of his sight and reach. The call of a bird is that sound which it is able to make, when about a month old; it is, in most instances, a repetition of one and the same note, is retained by the bird as long as it lives, and is common, generally, to both the cock and hen. The next stage in the notes of a bird is termed, by the bird-catchers, recording. This attempt in the nestling to sing may be compared to the imperfect endeavour in a child to babble. A young bird commonly continues to record for 10 or 11 months, when he is able to execute every part of his song, which afterwards continues fixed, and is scarcely ever altered. When the bird is thus become perfect in his lesson, he is said to sing his song round, or in all its varieties of passages, which he connects together, and executes without a pause.

Notes in birds are no more innate than language is in man, and depend entirely on the master under which they are bred, as far as their organs will enable them to imitate the sounds which they have frequent opportunities of hearing. Mr. B. educated nestling linnets under the three best singing larks, the skylark, woodlark, and titlark, every one of which, instead of the linnet's song, adhered entirely to that of their respective instructors. When the note of the titlark-linnet was thoroughly fixed, he hung the bird in a room with two

common linnets, for a quarter of a year, which were full in song; the titlark-linnet, however, did not borrow any passages from the linnet's song, but adhered steadfastly to that of the titlark. Having some curiosity to find out whether a European nestling would equally learn the note of an African bird, he educated a young linnet under a vengolina, which imitated its African master so exactly, without any mixture of the linnet-song, that it was impossible to distinguish the one from the other. This vengolina linnet was absolutely perfect, without ever uttering a single note by which it could have been known to be a linnet.

Mr. B. took a common sparrow from the nest when it was fledged, and educated him under a linnet: the bird, however, by accident, heard a goldfinch also, and his song was, therefore, a mixture of the linnet and goldfinch. Mr. B. educated a young robin under a very fine nightingale; which, however, began already to be out of song, and was perfectly mute in less than a fortnight. This robin afterwards sung three parts in four nightingale, and the rest of his song was what the bird-catchers call rubbish, or no particular note whatever. He educated a nestling robin under a woodlark-linnet, which was full in song, and hung very near to him for a month together; after which the robin was removed to another house, where he could only hear a skylark-linnet. The consequence was that the nestling did not sing a note of woodlark, though he afterwards hung him again just above the woodlark-linnet, but adhered entirely to the song of the skylark-linnet.

Some passages of the song in a few kinds of birds correspond with the intervals of our musical scale, of which the cuckoo is a striking and known instance: much the greater part, however, of such song is not capable of musical notations. 'As a bird's pitch is higher than that of any instrument, we are at a loss when we attempt to mark their notes in musical characters, which we can so readily apply to such as we can distinguish with precision. An insurmountable difficulty is, that the intervals used by birds are commonly so minute, that we cannot judge at all of them, from the more gross intervals into which we divide our musical octave. Though we cannot attain the more delicate and imperceptible intervals in the song of birds, yet many of them are capable of whistling tunes with our more gross intervals, as is well known by the common instances of piping bullfinches and canary birds.

Most people, who have not attended to the notes of birds, suppose that those of every species sing exactly the same notes and passages; which is by no means true, though it is admitted that there is a general resemblance. Thus the London bird-catchers prefer the song of the Kentish goldfinches, but Essex chaffinches; and when they sell the bird to those who can thus distinguish, inform the buyer that it has such a note, which is very well understood between them. Some of the nightingale-fanciers also prefer a Surrey bird to those of Middlesex. These differences in the song of birds of the same species cannot, perhaps, be compared to any thing more apposite than the varieties of the provincial dialects.

The nightingale seems to have been fixed on, almost universally, as the most capital of singing birds, which superiority it certainly may boldly challenge: one reason, however, of this bird's being more attended to than others is, that it sings in the night. In the first place, its tone is infinitely more mellow than that of any other bird, though, at the same time, by a proper exertion of its musical powers, it can be excessively brilliant. When this bird sang its song round, in its whole compass, Mr. B. has observed 16 different beginnings and closes, at the same time that the intermediate notes were commonly varied in their succession with such judgment as to produce a most pleasing variety. But it is not only in tone and variety that the nightingale excels; the bird also sings with superior judgment and taste. Mr. B. has observed, that his nightingale began softly like the ancient orators; reserving its breath to swell certain notes, which by this means had a most astonishing effect, and which eludes all verbal description.

The bird which approaches nearest to the excellence of the nightingale, in this respect, is the skylark; but then the tone is infinitely inferior in point of mellowness: most other singing birds have not above four or five changes. The next point of superiority in a nightingale is its continuance of song, without a pause, which Mr. B. has observed sometimes not to be less than 20 seconds. Whenever respiration, however, became necessary, it was taken with as much judgment as by an opera singer.

Mr. B. here inserts a table, by which the comparative merit of the British singing birds may be examined, in which the number 20 denotes the point of absolute perfection; —

	Mellowness of tone.	Compass.	Execution.
Nightingale	19	19	19
Skylark	4	18	18
Woodlark	18	12	8
Titlark	12	12	12
Linnet	12	16	18
Goldfinch	4	12	12
Chaffinch	4	8	8
Greenfinch	4	4	6
Hedge-sparrow	6	4	4
Aberdavine (or siskin)	2	4	4
Redpole	0	4	4
Thrush	4	4	4
Blackbird	4	2	2
Robin	6	12	12
Wren	0	4	4
Reed-sparrow	0	2	2
Blackcap, or the Norfolk mock-nightingale	14	14	14

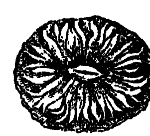
It may be asked, how birds originally came by the notes which are peculiar to each species. The answer, however, to this is, that the origin of the notes of birds, together with its gradual progress, is as difficult to be traced as that of the different languages in nations. The loss of the parent cock, at the critical time for instruction, has, doubtless, produced those varieties which are in the song of each species; because then the nestling has either attended to the song of some other birds, or, perhaps, invented some new notes of its own, which are afterwards perpetuated from generation to generation, till similar accidents produce other alterations.

The History of the Sea Anemonies. By Abbé Dicquemare, *at Havre de Grace.* *

The sea anemonies found on the coast of the Havre seem to constitute three different species. Those here put in the first class, because in certain positions they resemble most the flower known by the name of anemone, cling or adhere to rocks and stones, and are often found in the holes that chance to be in them, and seem to like the surface of the water. The outer shape of the body of this animal, when it

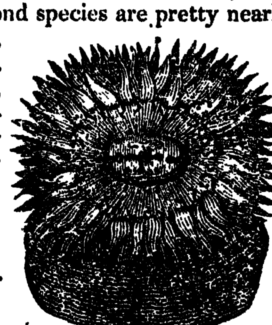
contracts itself, is much like a truncated cone, as in the engraving, with its basis fixed and strongly clinging to the rock. Its upper part is terminated with a hollow. This cone is often perpendicular to its basis: sometimes it lies in an oblique position to it, or the basis spreads itself irregularly; so that from a round it alters to an elliptical shape.

Sometimes it imitates pretty exactly the inclosing outleaves of anemonies, while the limbs of the animal are not unlike the shag, or inner part of these flowers, as in the engraving. At other times it assumes the shape



expressed by the other engraving. Indeed these animals alter their forms so often, that it would be difficult, perhaps, even impossible, to describe them exactly. One part of their body or limbs swells at times very considerably, at the expense of the rest. The figures and the particular observations will supply what is wanting here. With regard to their colours, they vary amazingly. Every hue of purple, green, brown, and violet, is to be seen blended together. A great number of them are of one uniform colour; while others are spotted either symmetrically, as in stripes, or in an irregular, but always pleasing manner. Most of them have round their basis a blue or white streak, broader or narrower, which produces a sort of ring. When many of these animals are put together at the bottom of a flattish and wide vessel, the whole appears as a bed of anemonies.

The sea anemonies of the second species are pretty nearly shaped out as those of the first, but they are much larger. Mr. D. had some, kept in sea-water, that were 18 or 20 inches in circumference. Their cloak or outer skin is rough like shagreen, or full of little knobs: see the engraving. They remain in the sand, sticking to the loose stones in it, and stretch out their limbs to the top, in order to lay hold of their prey, as soon as it touches the superficies of the sand. The



flower of poppies is said to be the plague and distress of painters, to represent exactly the variety and brilliancy of its colours; the same may be said of the sea anemonies of this

larger species. The purest white, carmine, and ultramarine, would hardly be bright enough to paint them properly. The limbs of some of them are of a moderate or dim colour, at the same time that the cloak is made up of the brightest colours. The mouth is in the centre of the upper part: it is not always shaped in the same manner in other anemonies as it is seen here, or at least does not always appear to be so. This anemone has five rows of limbs. There are 10 in the innermost row; the like number in the second; 20 in the third; 30 in the fourth; and 80 in the fifth. When the animal is out of the water, and is squeezed, it spirts out water at the mouth and at several of its limbs at the same time; so that it imitates pretty well the play of water-works. When the limbs are drawn in closer together, they give it the look of a flower, especially of an anemone.

What first offered itself to Mr. D.'s observations, is what distinguishes these animals from plants, viz. progressive motion, by the help of which they can shift their place; the other determinate motions, by which they are enabled to lay hold of their prey; the means they make use of to defend themselves; their deglutition, digestion, evacuations, and, lastly, the propagation of their species, &c. What little he has had an opportunity to see of those functions appears sufficient to place these creatures in the class of spontaneous animals, rather than in the dark indeterminate list of zoophytes.

In May, 1772, he clipped all the limbs of a purple anemone of the first species. Soon after, these limbs began to bud out again. The 30th of July they were clipped a second time, and grew again in less than a month. Having cut them a third time, they had a third shooting out. The same experiment on a green anemone had the like success. It seems these reproductions might extend as far, or be as often repeated, as patience and curiosity would admit. Several experiments have convinced him that one single limb of these anemonies being cut off retains a power to fasten itself to any small body that is brought near it, either by its end, or by the side towards the end, but not by that part where the clipping was made.

These animals can live a whole year, and perhaps much longer, without any other food than what they chance to find disseminated in the sea-water. They do not want many motions to procure their food, besides stretching out their limbs, to receive such as comes within their reach; and they remain surrounded with muscles, &c. without laying hold of any of them. He has given anemonies some of these mus-

cles alive, but with their shells closed, and about six lines in length. They were swallowed in that state; and 40, 50, and 60 hours after, the shells were thrown up at the mouth, empty and perfectly cleared, even from the small tendons which connect the fish to its shells. The anemonies swallow and digest small fish, and bits of larger fish, or of raw meat, when offered to them. When they cannot digest some of the food, they throw it up at the mouth, either whole or partly dissolved into a viscous liquor, which may, in some measure, be considered as their excrements.

Letter from the Sieur SEIGNETTE, *Mayor of La Rochelle, and second perpetual Secretary of the Academy of that City.*

THE experiment, of which I am going to give an account, was made in the presence of the Academy of this city. A live torpedo was placed on a table. Round another table stood five persons insulated. Two brass wires, each 13 feet long, were suspended to the ceiling by silken strings. One of these wires rested by one end on the wet napkin on which the fish lay; the other end was immersed in a basin full of water placed on the second table, on which stood four other basins likewise full of water. The first person put a finger of one hand in the basin in which the wire was immersed, and a finger of the other hand in the second basin. The second person put a finger of one hand in this last basin, and a finger of the other hand in the third, and so on successively, till the five persons communicated with one another by the water in the basins. The result of the experiment showed that the action of the torpedo is communicated by the same mediums as that of the electric fluid. The bodies which intercept the action of the one intercept, likewise, the action of the other. The effects produced by the torpedo resemble in every respect a weak electricity.

The effect of the animal was, in these experiments, transmitted through as great an extent and variety of conductors as almost at any time we had been able to obtain it, and the experiments included nearly all the points, in which its analogy with the effect of the Leyden phial had been observed.

The torpedo, on this occasion, dispensed only the distinct, instantaneous stroke, so well known by the name of the electric shock. That protracted but lighter sensation, that torpor or numbness which he at times induces, and from which he takes his name, was not then experienced from the animal; but it was imitated with artificial electricity, and shown to be pro-

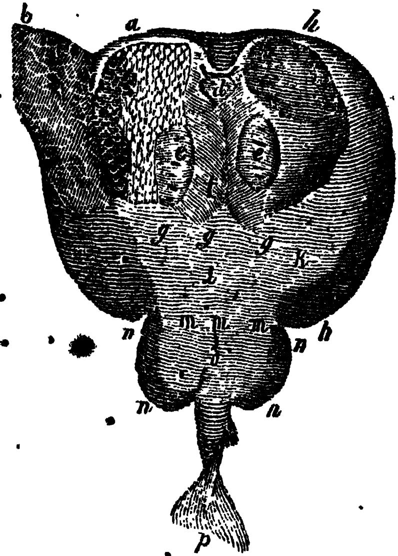
ducible by a quick consecution of minute shocks. This, in the torpedo, may perhaps be effected by the successive discharge of his numerous cylinders, in the nature of a running fire of musketry: the strong single shock may be his general volley. In the continued effect, as well as the instantaneous, his eyes, usually prominent, are withdrawn into their sockets. The same experiments, performed with the same torpedos, were, on the two succeeding days, repeated before numerous companies of the principal inhabitants of La Rochelle.

Several persons, forming as many distinct circuits, can be affected by one stroke of the animal, as well as when joined in a single circuit. For instance, four persons, touching separately his upper and lower surfaces, were all affected; two persons likewise, after the electricity had passed through a wire into a basin of water, transmitted it from thence, in two distinct channels, as their sensation convinced them, into another basin of water, whence it was conducted, probably in a united state, by a single wire. How much further the effect might be thus divided and subdivided into different channels, was not determined; but it was found to be proportionably weakened by multiplying these circuits, as it had been by extending the single circuit.

The organs themselves, when uncharged, appeared to be, not interiorly we might suppose, but rather exteriorly, conductors of a shock. An insulated person touching two torpedos, near each other, on a damp table, with his fingers placed, one on the organ of one fish, and another on the organ of the other, was sensible of shocks, sometimes delivered by one fish, and sometimes by the other, as might be discovered by the respective winking of their eyes. That the organs uncharged served some way or other as conductors was confirmed with artificial electricity in passing shocks by them, and in taking sparks from them when electrified. The electric effect was never perceived by us to be attended with any motion or alteration in the organs themselves, but was frequently accompanied with a little transient agitation along the cartilages which surround both organs.

The annexed figure represents the under surface of the female. *a*, An exposure, on flaying off the skin, of the right electric organ, which consists of white pliant columns, in a close, and for the most part hexagonal arrangement, giving the general appearance of a honeycomb in miniature. These columns have been sometimes denominated cylinders; but, having no interstices, they are all angular, and chiefly six-cornered.

b, The skin which covered the organ, showing, on its inner side, a hexagonal net-work. *c*, The nostrils in the form of a crescent. *d*, The mouth in a crescent contrary to that of the nostrils, furnished with several rows of very small hooked teeth. *e*, The branchial apertures, five on each side. *f*, The place of the heart. *g*, *g*, *g*, The place of the two anterior transverse cartilages, which, passing one above and the other below the spine, support the diaphragm, and uniting towards their extremities, form on either side a kind of clavicle and scapula. *h*, *h*, The outward margin of the great lateral fin. *i*, *i*, Its inner margin, confining with the electric organ. *k*, The articulation of the great lateral fin with the scapula. *l*, The abdomen. *m*, *m*, *m*, The place of the posterior transverse cartilage which is single, united with the spine, and supports on each side the smaller lateral fins. *n*, *n*, *n*, *n*, The two smaller lateral fins. *o*, The anus. *p*, The fin of the tail.



Anatomical Observations on the Torpedo. By JOHN HUNTER, *F.R.S.*

THE electric organs of the torpeao are placed on each side of the cranium and gills, reaching from thence to the semicircular cartilages of each great fin, and extending longitudinally from the anterior extremity of the animal to the transverse cartilage, which divides the thorax from the abdomen; and within these limits they occupy the whole space between the skin of the upper and of the under surfaces: they are thickest at the edges near the centre of the fish, and become gradually thinner towards the extremities. Each electric organ, at its inner longitudinal edge, is unequally

hollowed; being exactly fitted to the irregular projections of the cranium and gills. The outer longitudinal edge is a convex elliptic curve. The anterior extremity of each organ, makes the section of a small circle; and the posterior extremity makes nearly a right angle with the inner edge. Each organ is attached to the surrounding parts by a close cellular membrane, and also by short and strong tendinous fibres, which pass directly across, from its outer edge, to the semicircular cartilages. They are covered, above and below, by the common skin of the animal; under which there is a thin fascia spread over the whole organ. This is composed of fibres, which run longitudinally, or in the direction of the body of the animal: these fibres appear to be perforated in innumerable places; which gives the fascia the appearance of being fasciculated: its edges all around are closely connected to the skin, and at last appear to be lost, or to degenerate into the common cellular membrane of the skin.

Each organ of the fish under consideration is about five inches in length, and at the anterior end three in breadth, though it is but little more than half as broad at the posterior extremity. Each consists wholly of perpendicular columns, reaching from the upper to the under surface of the body, and varying in their lengths, according to the thickness of the parts of the body where they are placed; the longest column being about an inch and a half, the shortest about one fourth of an inch in length, and their diameters about two tenths of an inch. The figures of the columns are very irregular, varying according to situation and other circumstances. The greatest number of them are either irregular hexagons, or irregular pentagons; but from the irregularity of some of them, it happens that a pretty regular quadrangular column is sometimes formed. Those of the exterior row are either quadrangular or hexagonal; having one side external, two lateral, and either one or two internal. In the second row they are mostly pentagons. Their coats are very thin, and seem transparent, closely connected with each other, having a kind of loose network of tendinous fibres, passing transversely and obliquely, between the columns, and uniting them more firmly together. These are mostly observable where the large trunks of the nerves pass. The columns are also attached by strong inelastic fibres, passing directly from the one to the other.

The number of columns in different torpedo's appeared to be about 470 in each organ; but it varies according to the size of the fish. These columns increase, both in size and number, during the growth of the animal: new ones forming

perhaps every year on the exterior edges, as there they are much the smallest. This process may be similar to the formation of new teeth in the human jaw, as it increases. Each column is divided by horizontal partitions, placed over each other, at very small distances, and forming numerous interstices, which appear to contain a fluid. These partitions consist of a very thin membrane, considerably transparent. Their edges appear to be attached to one another, and the whole is attached by a fine cellular membrane to the inside of the columns. They are not totally detached from one another: I have found them adhering, at different places, by blood-vessels passing from one to another.

The number of partitions contained in a column of one inch in length, of a torpedo which had been preserved in proof-spirit, appeared on a careful examination to be 150; and this number, in a given length of column, appears to be common to all sizes in the same state of humidity; for by drying them they may be greatly altered: whence it appears probable that the increase in the length of a column, during the growth of the animal, does not enlarge the distance between each partition in proportion to that growth; but that new partitions are formed, and added to the extremity of the column from the fascia.

The partitions are very vascular: the arteries are branches from the veins of the gills, which convey the blood that has received the influence of respiration. They pass along with the nerves to the electric organ, and enter with them; they then ramify, in every direction, into innumerable small branches on the sides of the columns, sending in from the circumference all around, on each partition, small arteries, which ramify and anastomose on it; and passing also from one partition to another, anastomose with the vessels of the adjacent partitions. The veins of the electric organ pass out, close to the nerves, and run between the gills, to the auricle of the heart.

The nerves inserted into each electric organ arise by three very large trunks, from the lateral and posterior part of the brain. The first of these, in its passage outwards, turns round a cartilage of the cranium, and sends a few branches to the first gill, and to the anterior part of the head, and then passes into the organ towards its anterior extremity. The second trunk enters the gills between the first and second openings, and, after furnishing it with small branches, passes into the organ near its middle. The third trunk, after leaving the skull, divides into two branches, which pass to the electric organ through the gills: one between the second and third

openings, the other between the third and fourth, giving small branches to the gill itself. These nerves, having entered the organs, ramify in every direction, between the columns, and send in small branches, on each partition, where they are lost.

The magnitude and the number of the nerves bestowed on these organs, in proportion to their size, must on reflection appear as extraordinary as the phenomena they afford. Nerves are given to parts either for sensation or action. Now if we except the more important senses of seeing, hearing, smelling, and tasting, which do not belong to the electric organs, there is no part, even of the most perfect animal, which, in proportion to its size, is so liberally supplied with nerves; nor do the nerves seem necessary for any sensation which can be supposed to belong to the electric organs. And with respect to action, there is no part of any animal with which I am acquainted, however strong and constant its natural actions may be, which has so great proportion of nerves. If it be then probable, that those nerves are not necessary for the purposes of sensation or action, may we not conclude that they are subservient to the formation, collection, or management of the electric fluid; especially as it appears evident, from Mr. Walsh's experiments, that the will of the animal does absolutely control the electric powers of its body; which must depend on the energy of the nerves. How far this may be connected with the power of the nerves in general, or how far it may lead to an explanation of their operations, time and future discoveries alone can fully determine.

Observations on the Solar Spots. By ALEXANDER WILSON, *M.D. Anno* 1774.

ASTRONOMERS will remember, that a spot of an extraordinary size appeared on the sun in Nov. 1769. On the 22d, Dr. W. had a view of the sun through an excellent Gregorian telescope of 26 inches' focus, which magnified 112 times. The spot was not far from the sun's western limb, and below his equatorial diameter. The atmosphere being very clear, and free from all tremor and undulation, it was pleasant to see the nucleus of the spot, and the shady zone or umbra which surrounded it, so very distinct.

Next day he again saw the spot, having its nucleus and umbra very sharply defined. He now found, however, a remarkable change; for the umbra, which before was equally broad all round the nucleus, appeared much contracted on that part which lay towards the centre of the disc, while the

other parts of it remained nearly of their former dimensions. This change of the umbra seemed somewhat extraordinary, as it was the very reverse of what he expected from the motion of the spot towards the limb.

But next day at 10 o'clock, he had another observation, and discovered changes which were still more unexpected. The distance of the spot from the limb was now about 24". By this time the contracted side of the umbra had entirely vanished; and the figure of the nucleus was now remarkably changed, from what it had been the preceding day. This alteration of the figure appeared evidently to have taken place on that side which had now lost the umbra, the breadth of the nucleus being thereby more suddenly impaired than it ought to have been, by the motion of the spot across the disc.

One of two things seemed necessarily to be the cause; either, they were owing to some physical alteration or wasting of the spot, and of that part of it where the deficiency of the umbra was observed; or else, they were owing to the nearer approach of the spot to the limb, by the sun's rotation on his axis. The last of these two ideas had no sooner struck him, than he began to suspect that the central part, or nucleus of this spot, was beneath the level of the sun's spherical surface; and that the shady zone or umbra, which surrounded it, might be nothing else but the shelving sides of the luminous matter of the sun, reaching from his surface, in every direction, down to the nucleus: for, on this supposition, he perceived that a just account could be given of the changes of the umbra, and of the figure of the nucleus, above described.

Being thus persuaded of the depression of this great spot below the surface, he immediately set about examining smaller ones, in order to discover if they were of the same kind. With this view, he began a course of observations, that from them he might either make the inference universal, or limit it, as the phenomena should point out. Dr. W. was not long engaged in this pursuit, before he perceived in them the same changes of their umbræ which have been described above. This was manifest in spots of any considerable size, when the air was favourable, and the telescope well adjusted for distinct vision. In general, he found that the umbra thus changes, when a spot is about a minute distant from the limb, at a medium. From all these observations, may we not safely conclude, that every spot consisting of a nucleus and surrounding umbra is of the same kind with those above described.

It appears, then, that the solar spots are immense excavations in the body of the sun; and that what hitherto has been called

the nucleus is the bottom, and what has been called the umbra the sloping sides of the excavation. It also appears that the solar matter, at the depth of the nucleus, does not emit light, or emits so little, as to appear dark compared to that resplendent substance at the surface; that this beauteous substance is at the surface most fulgid; and when any of it is seen below the general level, forming the sides of an excavation, that then its lustre is somehow impaired, so as to give the appearance of a surrounding umbra.

Many curious speculations naturally present themselves. By what mysterious process is it, that those astonishing excavations are at first produced? What is the nature of that shining substance, which is thereby perpetually disturbed? To what are we to ascribe the darkness of the nucleus, and the diminished lustre of the umbra? And what conceptions are we to form of the many strange changes, and at length of the final decay of all these appearances, by which those regions of the sun, that were so hurt and disfigured, again undergo a renovation?

Though we may never have a competent notion of the nature and qualities of this shining and resplendent substance, or of the means by which the excavations in it are formed; we however discover, in their production, the agency of some mighty, though unknown cause, which is there often exerting itself. Though we manifestly behold its effects, yet the mode of its operations may perhaps remain unsearchable. But if we were here to venture a conjecture, might we not suppose that the luminous matter is so disturbed, and the excavations in it occasioned, by the working of some sort of elastic vapour, generated within the dark globe? And might not this elastic principle, by its expansion, swell into such a volume, as to reach up to the surface of the luminous matter, which would thus be separated and laid aside in all directions?

According to the view of things given in the foregoing queries, there would seem to be something very extraordinary in the dark and unignited state of the great internal globe of the sun. Does not this seem to indicate, that the luminous matter which encompasses it derives not its splendour from any intensity of heat? For if this were the case, would not the parts underneath, which would be perpetually in contact with that glowing matter, be heated to such a degree as to become luminous and bright? At the same time it must be confessed, that though the internal globe was in reality much ignited, yet when any part of it, forming the nucleus of a spot, is exposed to our view, and is seen in competition with

a substance of such amazing splendour, it is no wonder that an inferior degree of light should in these circumstances be unperceivable.

As to the faculæ, or brighter parts of the sun, we are at a loss for their origin. It may in gener l be remarked, that though we have obtained an experimental proof, that the luminous matter acquires some degree of shade, when forming the sides of an excavation, yet it is uncertain if this be merely the effect of position, and much more so, if any different modification of position could ever dispose it to put on a brighter or more fulgid appearance. Yet, after all, may not these faculæ, &c. depend on some irregularities in the bright surface of the sun? For may not the luminous matter, by being agitated by the same cause to which the spots owe their origin, though in a less degree, have its surface perpetually disturbed, and made irregular, and thus give occasion to a variety of light and shade, sufficient, perhaps, to produce the phenomena under consideration? And does not this conjecture receive further confirmation, when we consider, that these faculæ, &c. are found only in that zodiac within which the spots appear, and that they always abound most in the neighbourhood of the spots themselves, or where spots recently have been? For in those undisturbed regions of the sun that lie towards his poles, and where no spots ever appear, we never discover any diversity of appearance.

Thus Dr W has endeavoured to give a general idea of the production, changes, and decay of the solar spots, considered as excavations in the body of the sun; a thing which seems to be established from the observations described in the first part of this paper. But concerning the nature of that mighty agency, which occasions those amazing commotions in the luminous matter, or concerning the density, viscidity, and other qualities of this matter, or the manner in which it is disturbed in the middle zone only, and not at the polar regions, and many such other questions, he freely confesses, that they far surpass his knowledge.

Experiments and Observations on the Gymnotus Electricus, or Electrical Eel. By HUGH WILLIAMSON, *M.D. of Philadelphia.*

A SEA-FARING man brought to this city a large eel, that had been caught in the province of Guiana, a little to the westward of Surinam. It had the extraordinary power of communicating a painful sensation, like that of an electrical

shock, to people who touched it, and of killing its prey at a distance. The eel was three feet seven inches long, and about two inches thick near the head. On a transient view it resembled one of our common eels both in shape and colour; but its head was flat, and its mouth wide, like that of a cat-fish, without teeth.

On touching the eel with one hand, Dr. W. perceived such a sensation in the joints of his fingers as he received on touching a prime conductor or charged phial, when no circle was formed; or such as he had received, when a few sparks of the electric fluid have been conveyed through his fingers only. On touching the eel more roughly, he perceived a similar effect in his wrist and elbow. Touching the eel with an iron rod, 12 inches long, he perceived the like sensation in the joints of the thumb and fingers with which he held the metal. While another person provoked the eel by touching it, Dr. W. put his hand into the water at the distance of three feet, and felt such a sensation in the joints of his fingers as when he had touched the eel, but not so painful. Some small fishes were thrown into the water where he was swimming; he killed them immediately, and swallowed them. A cat-fish, that was at least one inch and a half thick, was thrown into the water where the eel was swimming; he killed it also, and attempted to swallow it, but could not. To discover whether the eel killed those fish by an emission of the same fluid with which he affected the hand when touched, Dr. W. put his hand into the water, at some distance from the eel; another cat-fish was thrown into the water; the eel swam up to it, but presently turned away, without offering any violence. After some time he returned; when, seeming to view it for a few seconds, he gave it a shock, by which it instantly turned up its belly, and continued motionless; at that very instant Dr. W. felt such a sensation in the joints of his fingers as in the former experiment.

A great variety of other experiments were made by two persons, one touching the eel near its head, the other putting his hand into the water, or touching it near the tail, forming a communication at the same time between their hands, which were out of the water, by pieces of charcoal, rods of iron or brass, a piece of dry wood, glass, silk, &c. The uniform result of all these experiments was, that whatever usually conveys the electrical fluid, would also convey the fluid discharged by the eel; and vice versâ, a brass chain, that had very many links in it, would not convey it, unless when the shock was severe, or the chain tense.

From the above experiments it appears, 1. That the Guiana eel has the power of communicating a painful sensation to animals that touch or come near it. 2. That this effect depends entirely on the will of the eel; that it has the power of giving a small shock, a severe one, or none at all, just as circumstances may require. 3. That the shock given, or the painful sensation communicated, depends not on the muscular action of the eel, since it shocks bodies in certain situations at a great distance; and since particular substances only will convey the shock, while others, equally elastic or hard, refuse to convey it. 4. That the shock must therefore depend on some fluid, which the eel discharges from its body. 5. That as the fluid discharged by the eel affects the same parts of the human body that are affected by the electric fluid; as it excites sensations perfectly similar; as it kills or stuns animals in the same manner; as it is conveyed by the same bodies that convey the electric fluid, and is not conveyed by other bodies that do not convey the electric fluid, it must also be the true electrical fluid, and the shock given by this eel must be the true electrical shock.

An Account of the Gymnotus Electricus. By JOHN HUNTER, *F.R.S*

THIS fish, on the first view, appears very much like an eel, from which resemblance it has most probably got its name; but it has none of the specific properties of that fish. This animal may be considered, both anatomically and physiologically, as divided into two parts; viz. the common animal part, and a part which is superadded, viz. the peculiar organ. The first, or common animal part, is so contrived as to exceed what was necessary for itself, in order to give situation, nourishment, and most probably the peculiar property to the second. The last part, or peculiar organ, has an immediate connection with the first; the body affording it a situation; the heart, nourishment; and the brain, nerves, and probably its peculiar powers. For the first of these purposes, the body is extended out in length, being much longer than would be sufficient for what may be called its progressive motion. For the real body, or that part where the viscera and parts of generation lie, is situated, with respect to the head, as in other fish, and is extremely short; so that, according to the ordinary proportions, this should be a very short fish.

The organs which produce the peculiar effect of this fish,

constitute nearly one half of that part of the flesh in which they are placed, and perhaps make more than one third of the whole animal. There are two pair of these organs, a larger and a smaller; one being placed on each side. The large pair occupy the whole lower or anterior, and also the lateral part of the body, making the thickness of the fore or lower parts of the animal, and run almost through its whole length; viz. from the abdomen to near the end of the tail. It is broadest on the sides of the fish at the anterior end, where it incloses more of the lateral parts of the body, becomes narrower towards the end of the tail, occupying less and less of the sides of the animal, till at last it ends almost in a point. These two organs are separated from one another at the upper part, by the muscles of the back, which keep their posterior or upper edges at a considerable distance from one another; below that, and towards the middle, they are separated by the air-bag; and at their lower parts they are separated by the middle partition.

The small organ lies along the lower edge of the animal, nearly to the same extent as the other. Its situation is marked externally by the muscles which move the fin under which it lies. Its anterior end begins nearly in the same line with the large organ, and just where the fin begins. It terminates almost insensibly near the end of the tail, where the large organ also terminates.

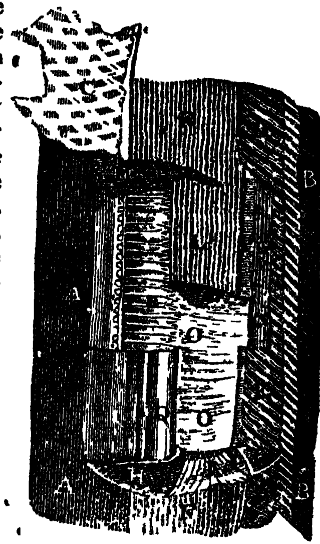
The structure is extremely simple and regular, consisting of two parts; viz. flat partitions or septa, and cross divisions between them. The outer edge of these septa appear externally in parallel lines nearly in the direction of the longitudinal axis of the body. These septa are thin membranes, placed nearly parallel to one another. Their lengths are nearly in the direction of the long axis, and their breadth is nearly the semidiameter of the body of the animal. They are of different lengths, some being as long as the whole organ. Their breadths differ in different parts of the organ. They are in general broadest near the anterior end, answering to the thickest part of the organ, and become gradually narrower towards the tail, however they are very narrow at their beginnings or anterior ends. Those nearest the muscles of the back are the broadest, owing to their curved or oblique situation on these muscles, and get gradually narrower towards the lower part, which is in a great measure owing to their becoming more transverse, and also to the organ becoming thinner at that place. They have an outer and an

inner edge. The outer is attached to the skin of the animal, to the lateral muscles of the fin, and to the membrane which divides the great organ from the small; and the whole of their inner edges are fixed to the middle partition formerly described, also to the air-bladder, and three or four terminate on that surface which incloses the muscles of the back. These septa are at the greatest distance from one another at their exterior edges near the skin, to which they are united; and as they pass from the skin towards their inner attachments, they approach one another. The distances between these septa will differ in fishes of different sizes. In a fish of two feet four inches in length, I found them to be about $\frac{1}{7}$ of an inch distant from one another; and the breadth of the whole organ, at the broadest part, about an inch and a quarter, in which space were 34 septa. The small organ has the same kind of septa, in length passing from end to end of the organ, and in breadth passing quite across: they run somewhat serpentine, not exactly in straight lines. They appear to be so close as even to touch. In an inch in length there are about 240, which multiplies the surface in the whole to a vast extent.

The nerves in this animal may be divided into two kinds; the first, appropriated to the general purposes of life; the second, for the management of this peculiar function, and very probably for its existence. They arise in general from the brain and medulla spinalis, as in other fish; but those from the medulla are much larger than in fish of equal size, and larger than is necessary for the common operations of life. The nerve which arises from the brain, and passes down the whole length of the animal (which I believe exists in all fish), is larger in this than in others of the same size, and passes nearer the spine. This nerve is as singular an appearance as any in this class of animals; for surely it must appear extraordinary, that a nerve should arise from the brain to be lost in common parts, while there is a medulla spinalis giving nerves to the same parts. It must still remain one of the inexplicable circumstances of the nervous system. In this fish, as well as in the torpedo, the nerves which supply the organ are much larger than those bestowed on any other part for the purposes of sensation and action; but it appears to me, that the organ of the torpedo is supplied with much the largest proportion.

The engraving is a section of the whole thickness of the fish near the upper part. The skin is removed as far back as the

posterior edge of the organ, and the other parts immediately belonging to it, such as the medulla spinalis. There are several pieces or sections taken out of the organ, which expose every thing that has any relation to it. At the upper and lower ends of the figure FF, the organ is entire, the skin only being removed. A A, the body of the animal, near the back, covered by the skin; B B, the belly-fin, covered also by the skin; C, part of the skin removed from the organ, and turned back; D D, the muscles which move the fin laterally, and which immediately cover the small organ; E, the middle muscles of the fin, which lie immediately between the two small organs; F F, the outer surface



of the large organ, as it appears when the skin is removed; G, the small organ, as it appears when the lateral muscles are removed; H H, the cut ends of the muscles of the back, which have been removed to expose the deeper-seated parts; I I, the cut ends of the large organ, part of which has also been removed, to expose the deeper-seated parts; K, the cut end of the small organ; L, a part of the large organ, the rest having been removed; M, the cut end of the above section; N, a section of the small organ; O O, the middle partition which divides the two large organs; P, a fatty membrane, which divides the large organ from the small; Q, the air-bladder; R, the nerves going to the organ; S, the medulla spinalis; T, the singular nerve.

Observations made on the Mountain Schehallien, for its Attraction. By the Rev. NEVIL MASKELYNE, *B. D. F. R. S. and Astronomer Royal.*

A COMMITTEE was appointed, of which number I was one, to consider of a proper hill on which to try the experiment, and to prepare every thing necessary for carrying the design into execution.

Perthshire afforded a remarkable hill, nearly in the centre of Scotland, of sufficient height, tolerably detached from other hills, and considerably larger from east to west than from north to south, called by the people of the low country Maiden-pap, but by the neighbouring inhabitants, Schehallien.

The quantity of attraction of the hill, the grand point to be determined, is measured by the deviation of the plumb-line from the perpendicular, occasioned by the attraction of the hill, or by the angle contained between the actual perpendicular and that which would have obtained if the hill had been away. On the south side of the hill, the plumb-line being carried northward at its lower extremity will occasion the apparent zenith, which is in the direction of the plumb-line, continued backwards, to be carried southward, and consequently to approach the equator; and, therefore, the latitude of the place will appear too small by the quantity of the attraction, the distance of the equator from the zenith being equal to the latitude of the place. The contrary happens on the north side of the hill; the lower extremity of the plumb-line being there carried southward, will occasion the apparent zenith to be carried northward, or from the equator, and the latitude of the place will appear too great by the quantity of the attraction. Thus the less latitude appearing too small by the attraction on the south side, and the greater latitude appearing too great by the attraction on the north side, the difference of the latitudes will appear too great by the sum of the two contrary attractions; if, therefore, there is an attraction of the hill, the difference of latitude by the celestial observations ought to come out greater than what answers to the distance of the two stations measured trigonometrically, according to the length of a degree of latitude in that parallel, and the observed difference of latitude subtracted from the difference of latitude inferred from the terrestrial operations, will give the sum of the two contrary attractions of the hill. To ascertain the distance between the parallels of latitude passing through the two stations on contrary sides of the hill, a base must be measured in some level spot near the hill, and connected with the two stations by a chain of triangles, the direction of whose sides, with respect to the meridian, should be settled by astronomical observations.

Thus there were three principal operations requisite to be formed: 1. To find by celestial observations the apparent difference of latitude between the two stations, chosen on the north and south sides of the hill. 2. To find the distance

between the parallels of latitude. 3. To determine the figure and dimensions of the hill.

By the calculation of two triangles, formed by the two cairns and the two stations of the observatory, the distance between the parallels of latitude passing through the two stations on each side the hill comes out 4364.4 feet, which, according to M. Bouguer's table of the length of a degree in this latitude of 56° 40′, at the rate of 101.64 English feet to one second, answers to an arc of the meridian of 42″.94. The other series of triangles carried across the hill gives the same distance of the parallels only 10 feet less, and, consequently, the arc of the meridian only $\frac{1}{10}$ of a second less. Thus the difference of latitude found by the astronomical observations comes out greater than the difference of latitude answering to the distance of the parallels, the former being 54″.6, the latter only 42″.94. The difference 11″.6 is to be attributed to the sum of the two contrary attractions of the hill.

The attraction of the hill, computed in a rough manner, on the supposition of its density being equal to the mean density of the earth, and the force of attraction being inversely as the square of the distances, comes out about double this. Whence it should follow, that the density of the hill is about half the mean density of the earth.

Account of a Woman in the Shire of Ross living without Food or Drink. By Dr. MACKENZIE.

JANET M'LEOD, unmarried, aged 33 years and some months, daughter of Donald M'Leod, of Kincardine, Ross-shire; in the 15th year of her age had a pretty sharp epileptic fit; she had till then been in perfect health, and continued so till about four years after, when she had a second fit, which lasted a day and night; and a few days afterwards, she was seized with a fever of several weeks' continuance, from which she had a very tedious recovery of several months. She took to her bed, complaining much of her heart and head; and afterwards she never rose out of it except when lifted, seldom spoke a word, and had so little craving for food, that at first her parents could only by compulsion get her to take as much as would support a sucking infant: afterwards she gradually fell off from taking even that small quantity; so that, at Whitsuntide, 1763, she totally refused food and drink, and her jaw became so fast locked, that it was with the greatest difficulty her father was able with a knife or other methods to open her teeth so as to

admit a little thin gruel or whey, and of which so much generally ran out at the corners of her mouth, that they could not be sensible that any of it had been swallowed.

About this time, they got a bottle of the water from a medicinal spring in Brea-mer, of which they endeavoured to get her to swallow a part, by pouring some out of a spoon between her lips, her jaws all the while fast locked, but it all ran out. With this, however, they rubbed her throat and jaws, and continued the trial to make her swallow, rubbing her throat with the water that ran out of her mouth for three mornings together. On the third morning, during this operation, she cried, "Give me more water;" when all that remained of the bottle was given her, which she swallowed with ease. These were the only words she spoke for almost a year, and she continued to mutter some more for 12 or 14 days, after which she did not speak, and rejected, as formerly, all sorts of nourishment and drink, till July, 1765, when a sister of hers thought, by some signs she made, that she wanted her jaws opened; which her father effected by putting the handle of a horn-spoon between her teeth. She said then, intelligibly, "Give me a drink;" and drank at one draught about a pint of water.' Her father then asked her, "Why she would not make some signs, though she could not speak, when she wanted a drink?" She answered, "Why should she, when she had no desire?" At this period they kept the jaws asunder with a bit of wood, imagining she got her speech by her jaws being opened, and continued them thus wedged about 20 days, though in the first four or five days she had wholly lost the power of utterance. At last they removed the wedge, as it made her lips sore. At this time she was sensible of every thing done or said about her; and when her eye-lids were opened for her, she knew every body; and when the neighbours in their visits lamented her condition, they could observe a tear stand in her eye.

The situation and appearances of the patient were carefully examined the 21st of October, 1767, by Dr. M., who likewise, in October, 1772, being informed that the patient was recovering, visited her, and found her condition to be as follows: About a year preceding this last date, her parents one day returning from their country labours (having left their daughter, as for some years before, fixed to her bed,) were greatly surprised to find her sitting on her hams, on the side of the house opposite to her bed-place, spinning with her mother's distaff. Dr. M. asked, whether she ever ate or drank? whether she had any of the natural evacuations?

whether she ever spoke or attempted to speak? And was answered, that she sometimes crumbled a bit of oat or barley cake in the palm of her hand, as if to feed a chicken; that she put little crumbs of this into the gap of her teeth, rolled them about for some time in her mouth, and then sucked out of the palm of her hand a little water, whey, or milk; and this, once or twice a day, and even that by compulsion: that the egesta were in proportion to the ingesta; that she never attempted to speak; that her jaws were still fast locked, her hamstrings tight as before, and her eyes shut. On opening her eye-lids Dr. M. found the eye-balls turned up under the edge of the os frontis: her countenance was ghastly, her complexion pale, her skin shrivelled and dry, and her whole person rather emaciated; her pulse with the utmost difficulty to be felt. She seemed sensible and tractable in every thing, except in taking food; for, at his request, she went through her different exercises, spinning on the distaff, and crawling about on her hams; by the wall of the house, with the help of her hands; but when desired to eat, she showed the greatest reluctance, and indeed cried before she yielded; and this was no more than, as he had said, to take a few crumbs, enough to feed a bird, and to suck half a spoonful of milk from the palm of her hand. On the whole, her existence was little less wonderful at this time than when he first saw her, when she had not swallowed the smallest particle of food for years together.

Of Persons who could not distinguish Colours. By Mr. J. HUDDART.

THE chief subject of this paper was one Harris, who lived at Mary-port, in Cumberland, near which place, viz. at Allonby, Mr. Huddart lived. Mr. H. had often heard from others that Harris could discern the form and magnitude of all objects very distinctly, but could not distinguish colours. This report having excited Mr. H.'s curiosity he conversed with him frequently on the subject. The account he gave was this: that he had reason to believe other persons saw something in objects which he could not see; that their language seemed to mark qualities with confidence and precision, which he could only guess at with hesitation, and frequently with error. His first suspicion of this arose when he was about four years old. Having by accident found in the street a child's stocking he carried it to a neighbouring house to enquire for the owner: he observed the people called it a red stocking, though he did not understand why they gave it that denomination, as

he himself thought it completely described by being called a stocking. The circumstance, however, remained in his memory, and with other subsequent observations led him to the knowledge of his defect. He observed, also, that, when young, other children could discern cherries on a tree by some pretended difference of colour, though he could only distinguish them from the leaves by their difference of size and shape. He noticed, too, that by means of this difference of colour they could see the cherries at a greater distance than he could, though he could see other objects at as great a distance as they; that is, where the sight was not assisted by the colour. Large objects he could see as well as other persons; and even the smaller ones if they were not enveloped in other things, as in the case of cherries among the leaves.

Mr. H. believes he could never do more than guess the name of any colour; yet he could distinguish white from black, or black from any light or bright colour. Dove or straw-colour he called white, and different colours he frequently called by the same name; yet he could discern a difference between them when placed together. In general, colours of an equal degree of brightness, however they might otherwise differ, he frequently confounded together. Yet a striped riband he could distinguish from a plain one; but he could not tell what the colours were with any tolerable exactness. Dark colours in general he often mistook for black, but never imagined white to be a dark colour, nor a dark to be a white colour.

He had two brothers in the same circumstances as to sight.

Of the Heat, &c. of Animals and Vegetables. By Mr. J. Hunter, F.R.S.

It plainly appears, that the living principle will not allow the heat of animals to sink much lower than the freezing point, though the surrounding atmosphere be much colder, and that in such a state they cannot support life long; but it may be observed, that most vegetables of every country can sustain the cold of their climate. In very cold regions, as in the more northern parts of America, where the thermometer is often 50° below 0, where people's feet are known to freeze and their noses to drop off if great care be not taken, yet the spruce-fir, birch, juniper, &c. are not affected.

Yet that vegetables can be affected by cold daily experience evinces; for the vegetables of every country are affected if the season be more than ordinarily cold for that country, and some more than others; for in the cold climates above mentioned, the life of the vegetable is often obliged to give

way to the cold of the country: a tree shall die by the cold, then freeze and split into a great number of pieces, and in so doing produce considerable noise, giving loud cracks which are often heard at a great distance.

After having endeavoured to find out the comparative heat between vegetables and the atmosphere, when the vegetables were in action, I next made my experiments on them when they were in the passive life. As the difference was very little when in their most active state, I could expect but very little when the powers of the plant were at rest. From experiment on the more imperfect classes of animals it plainly appears, that though they do not resist the effects of extreme cold, till they are brought to the freezing point, they then appear to have the power of resisting it, and of not allowing their cold to be brought much lower. To see how far vegetables are similar to those animals in this respect, I made several experiments: I however suspected them not to be similar, because such animals will die in a cold in which vegetables live; I therefore supposed that there is some other principle. I did not confine these experiments to the walnut-tree, but made similar ones on several trees of different kinds, as pines, yews, poplars, &c. to see what was the difference in different kinds of trees. The difference proved not to be great, not above a degree or two: however, this difference, though small, shows a principle in life, all other things being equal; for as the same experiments were made on a dead tree, which stood with its roots in the ground, similar to the living ones, they became more conclusive.

For the sake of brevity, I have drawn up my experiments, which were made on different trees, into two tables, as they were made at two different degrees of heat of the atmosphere, including those made in the time of the very hard frost in the winter of 1775-6. They were as follow: —

1. *The Atmosphere at* 29°

Names.	Heat.
Carol. poplar - -	29½°
Engl. poplar - -	29½
Orien. plane - -	30
Occid. plane - -	30
Carol. plane - -	30
Birch - - -	29½
Scotch fir - -	28½
Cedar Libanon -	28½
Arbutus - -	30

2. *The Atmosphere at* 27°

Names.	Heat.
Spruce fir - -	32°
Scotch fir - -	28
Silver fir - -	30
Weymouth fir -	30
Yew - -	30
Holly - -	30
Plumb-tree -	31½
Dead cedar -	29
Ground under snow	34

The Force of fired Gunpowder, and the initial Velocities of Cannon Balls, determined by Experiments. By Mr. CHARLES HUTTON, *F.R.S.*

THE intention of the experiment is to discover the actual velocity with which a ball issues from a piece, in the usual practice of artillery. This velocity is very great; from 1000 to 2000 feet in a second of time. For conveniently estimating so great a velocity, the first thing necessary is to reduce it, in some known proportion, to a small one. This we may conceive to be effected thus: Suppose the ball, with a great velocity, to strike some very heavy body, as a large block of wood, from which it will not rebound, so that they may proceed forward together after the stroke. By this means it is obvious, that the original velocity of the ball may be reduced in any proportion, or to any slow velocity, which may conveniently be measured, by making the body struck to be sufficiently large; for it is well known, that the common velocity, with which the ball and block of wood would move forward after the stroke, bears to the original velocity of the ball only the same ratio which the weight of the ball has to that of the ball and block together. Thus, then, velocities of 1000 feet in a second are easily reduced to those of two or three feet only; which small velocity being measured by any convenient means, then the number denoting it being increased in the proportion of the weight of the ball to the weight of the ball and block together, the original velocity of the ball itself will thus be obtained.

The number of rounds or shot was eight, and the circumstances and results as exhibited in the following table: —

Weight of powder.	Diam. of the ball.	Velocity per sec.
Oz.	Inches.	Feet.
2	1.98	458
2	1.98	631
2	1.98	650
2	1.97	646
2	1.97	604
2	1.96	598
4	1.97	881
4	1.96	950

The second course was performed on the 3d of June, 1775, which was a clear, dry day, but windy.

Weight of powder.	Diam of the ball.	Velocity per sec.
Oz.	Inches.	Feet.
2	2.08	800
2	2.08	1003
2	2.08	943
2	2.08	767
2	2.08	731

It is very remarkable, that in the experiments of this day, the mean velocity with two ounces of powder, is 973, whereas it was no more than 626 in the former day with the same quantity of powder, though the balls were heavier with the greater velocity, in the ratio of 19 to 17 nearly.

The third course was made on the 12th of June, 1775, being a clear dry, and calm day.

Weight of powder.	Diam. of the ball.	Velocity per sec.
Oz.	Inches.	Feet.
2	2.080	700
2	2.036	799
2	2.045	715
4	2.062	880
4	2.036	1163
4	2.045	1087

Here the common mean weight of the ball is 18⅔ ounces, the mean velocity with two ounces of powder is 738, and that with four ounces of powder is 1013 feet per second. The ratio of these two velocities is that of 1 to 1.414; that is, accurately the ratio of the square roots of the quantities of powder.

An Account of a remarkable Imperfection of Sight. In a Letter from J. Scott.

I AM very willing to inform you of my inability concerning colours, as far as I am able from my own common observation. I will now inform you what colours I have the least knowledge of. I do not know any green in the world; a pink colour and a pale blue are alike, I do not know one from the other. A full red and a full green the same, I have often thought them a good match; but yellows, light, dark, and middle, and all degrees of blue, except those very pale, commonly called sky, I know perfectly well, and can discern a deficiency, in any of those colours, to a particular nicety: a full purple and deep blue sometimes baffle me.

An Account of the Calculations made from the Survey and Measures taken at Schihallien, in order to ascertain the Mean Density of the Earth. By Charles Hutton, *Esq. F. R. S*

The effect of the attraction at the northern observatory was to that at the southern one nearly as 70 is to 80, or as 7 to 9 nearly. This difference is to be attributed chiefly to the effect of the hills on the south of the southern observatory, which were considerably greater and nearer to it than those on the back of the northern observatory.

In order now to compare this attraction with that of the whole earth, this body may be considered as a sphere, and the observatories as placed at its surface; since the very small differences of these suppositions from the truth are of no consequence at all in this comparison. Now the attraction of a sphere, on a body at its surface, is known to be $= \frac{2}{3} cd$, where d is = the diameter of the sphere, and $c = 3.1416 =$ the circumference of the circle of which the diameter is 1. But cd is = the circumference of the circle to the diameter d; and, therefore, the attraction of a sphere will be expressed by barely $\frac{2}{3}$ of its circumference; which is a theorem well adapted to the present computation. The length of a degree in the mean latitude of 45°, is 57028 French toises; and the same result nearly is obtained by taking a mean among all the measures of degrees there set down, that mean being 57038 toises. Mr. H. therefore uses the round number 57030 as probably nearer the truth. This number being multiplied by 6, the product 342180 shows the number of French feet in one degree; but the lengths of the Paris and London feet are as 76.734 to 72, that is, as 4.263 to 4; therefore, as 4 : 4.263 :: 342180 : 364678 = the English feet in one degree; and this being multiplied by 360, the whole number of degrees, there results 131284080 feet for the whole circumference, which are equal to 24864½ miles, making 69 $\frac{1}{15}$ to a degree in the mean latitude. Lastly, $\frac{2}{3}$ of 131284080 give 87522720 for the measure of the attraction of the whole earth.

Consequently, the whole attraction of the earth is to the sum of the two contrary attractions of the hill as the number 87522720 to 8811$\frac{1}{3}$, that is, as 9933 to 1 very nearly, on supposition that the density of the matter in the hill is equal to the mean density of that in the whole earth.

But the Astronomer Royal found, by his observations, that the sum of the deviations of the plumb-line, produced by the

two contrary attractions, was 11.6 seconds. Hence, then, it is to be inferred, that the attraction of the earth is actually to the sum of the attractions of the hill nearly as radius to the tangent of 11.6 seconds, that is, as 1 to .000056239, or as 17781 to 1; or as 17804 to 1 nearly, after allowing for the centrifugal force arising from the rotation of the earth about its axis.

Having now obtained the two results, namely, that which arises from the actual observations, and that belonging to the computation, on the supposition of an equal density in the two bodies, the two proportions compared must give the ratio of their densities, which is that of 17804 to 9933, or 1434 to 800 nearly, or almost as 9 to 5. And so much does the mean density of the earth exceed that of the hill.

It appears not unreasonable to suppose the mean specific gravity of the mountain to be from 2.7 to 2.75 or $2\frac{3}{4}$. Now $\frac{9}{5} \times 2\frac{3}{4}$ gives $\frac{99}{20}$, or almost 5; that is, under these circumstances, the medium density or specific gravity of the whole mass of the earth, in proportion to that of water, is nearly as 5 to 1, or that it is 5 times the weight of water.

Knowing, then, the mean density of the earth in comparison with water, and the densities of all the planets relatively to the earth, we can now assign the proportions of the densities of them all as compared to water, after the manner of a common table of specific gravities. And the numbers expressing their relative densities, in respect of water, are annexed.

Water -	1	Mars -	$3\frac{5}{7}$
The sun	$1\frac{4}{5}$	The moon -	$3\frac{5}{11}$
Mercury -	$10\frac{1}{6}$	Jupiter -	$1\frac{1}{6}$
Venus -	$6\frac{1}{5}$	Saturn -	$\frac{5}{11}$
The earth	5		

Account of an Infant Musician. By CHARLES BURNEY, *Doctor of Music and F. R. S.*

WM. CROTCH was born at Norwich, July 5. 1775. His father, by trade, a carpenter, having a passion for music, of which, however, he had no knowledge, undertook to build an organ, on which, as soon as it would speak, he learned to play two or three common tunes, with which, and such chords as were pleasing to his ear, he used to try the perfection of his instrument. About Christmas, 1776, when the child was only a year and a half old, he discovered a great inclination for music, by leaving even his food to attend to it when the organ was playing; and about Midsummer, 1777, he would

touch the key-note of his particular favourite tunes, in order to persuade his father to play them. Soon after this, as he was unable to name these tunes, he would play the two or three first notes of them, when he thought the key-note did not sufficiently explain which he wished to have played.

Being left, while his mother went out, in the dining-room with his brother, a youth of about 14 years old, he would not let him rest till he blew the bellows of the organ, while he sat on his knee and beat down the keys, at first promiscuously; but presently, with one hand, he played enough of "God save the King" to awaken the curiosity of his father, who being in a garret, which was his work-shop, hastened down stairs to inform himself who was playing this tune on the organ. When he found it was the child, he could hardly believe what he heard and saw. At this time he was exactly two years and three weeks old.

The next day he made himself master of the treble of the second part; and the day after he attempted the base, which he performed nearly correct in every particular, except the note immediately before the close, which, being an octave below the preceding sound, was out of the reach of his little hand. In the beginning of November, 1777, he played both the treble and base of "Let ambition fire thy mind," an old tune, which is, perhaps, now better known by the words to which it is sung in "Love in a Village," "Hope, thou nurse of young desire."

At this time, such was the rapid progress he had made in judging of the agreement of sounds, that he played the Easter hymn with full harmony; and in the last two or three bars of Hallelujah, where the same sound is sustained, he played chords with both hands, by which the parts were multiplied to six, which he had great difficulty in reaching on account of the shortness of his fingers. It was, also, to be observed, that in making a base to tunes which he had recently caught by his ear, whenever the harmony displeased him, he would continue the treble note till he had formed a better accompaniment.

Another wonderful part of his prematurity was the being able, at two years and four months old, to transpose into the most extraneous and difficult keys whatever he played; and now, in his extemporaneous flights, he modulates into all keys with equal facility. The last qualification which Dr. B. points out as extraordinary in this infant musician, is the being able to play an extemporary base to easy melodies, when performed by another person on the same instrument.

But these bases must not be imagined correct, according to the rules of counter-point, any more than his voluntaries. He generally gives, indeed, the key-note to passages formed from its common chord and its inversions, and is quick at discovering when the fifth of the key will serve as a base. At other times he makes the third of the key serve as an accompaniment to melodies, formed from the harmony of the chord to the key-note; and if simple passages are played slow, in a regular progression, ascending or descending, he soon finds out that thirds or tenths, below the treble will serve his purpose in furnishing an agreeable accompaniment.

Musical prodigies of this kind are not unfrequent: there have been several in Dr. B.'s memory on the harpsichord. But the two sons of the Rev. Mr. Wesley seem to have discovered, during early infancy, very uncommon faculties for the practice of music. Charles, the eldest, at 2¾ years old, surprised his father by playing a tune on the harpsichord readily, and in just time: soon after he played several, whatever his mother sung, or whatever he heard in the street. Samuel, the youngest, though he was three years old before he aimed at a tune, yet by constantly hearing his brother practise, and being accustomed to good music and masterly execution, before he was six years old arrived at such knowledge in music, that his extemporary performance on keyed instruments, like Mozart's, was so masterly in point of invention, modulation, and accuracy of execution, as to surpass, in many particulars, the attainments of most professors at any period of their lives. Indeed Mozart, when little more than four years old, is said to have been "not only capable of executing lessons on his favourite instrument, the harpsichord, but to have composed some in an easy style and taste, which were much approved;" and Samuel Wesley, before he could write, was a composer, and mentally set the airs of several oratorios, which he retained in memory till he was eight years old, and then wrote them down.

On the Eruption of Mount Vesuvius, in August, 1779. In a Letter from Sir Wm. Hamilton, K.B. F.R.S.

On the 5th of August, about two o'clock in the afternoon, Sir W. perceived, from his villa at Pausilippo, in the bay of Naples, whence he had a full view of Vesuvius, which is just opposite, and at the distance of about six miles in a direct line from it, that the volcano was in a most violent agitation: a white and sulphureous smoke issued continually and impe-

tuously from its crater, one puff impelling another, and by an accumulation of those, clouds of smoke resembling bales of the whitest cotton. Such a mass of them was soon piled over the top of the volcano, as exceeded the height and size of the mountain itself at least four times. In the midst of this very white smoke, an immense quantity of stones, scoriæ, and ashes, were shot up to a wonderful height, certainly not less than 2000 feet.

August 7. the volcano remained much in the same state; but about midnight its fermentation increased greatly. The second fever-fit of the mountain may be said to have manifested itself at this time. Sir W. was watching its motions from the mole of Naples, which has a full view of the volcano, and had been witness to several glorious picturesque effects produced by the reflection of the deep red fire, which issued from the crater of Vesuvius, and mounted up in the midst of the huge clouds, when a summer storm, called here a tropea, came on suddenly, and blended its heavy watery clouds with the sulphureous and mineral ones, which were already like so many other mountains piled over the summit of the volcano: at this moment a fountain of fire was shot up to an incredible height, casting so bright a light, that the smallest objects could be clearly distinguished at any place within six miles or more of Vesuvius.

August 8. Vesuvius was quiet till towards six o'clock in the evening, when a great smoke began to gather again over its crater, and about an hour after, a rumbling subterraneous noise was heard in the neighbourhood of the volcano: the usual throws of red-hot stones and scoriæ began, and increased every instant. At about nine o'clock there was a loud report, which shook the houses at Portici and its neighbourhood, to such a degree as to alarm their inhabitants, and drive them out into the streets; and many windows were broken, and walls cracked, by the concussion of the air from that explosion, though faintly heard at Naples. In an instant a fountain of liquid transparent fire began to rise, and, gradually increasing, arrived at so amazing a height as to strike every beholder with the most awful astonishment. The height of this stupendous column of fire could not be less than three times that of Vesuvius itself, which rises perpendicularly near 3700 feet above the level of the sea.

August 9. about nine o'clock in the morning, the fourth fever-fit of the mountain began to manifest itself by the usual symptoms, such as a subterraneous boiling noise, violent explosions of inflamed matter from the crater of the volcano,

accompanied with smoke and ashes, which symptoms increased every instant. The smoke was of two sorts; the one as white as snow, the other as black as jet. The white, as described in the former part of this journal, rolled gently mass over mass, resembling bales of the whitest cotton; and the black, composed of scoriæ and minute ashes, shot up with force in the midst of the white smoke, which, from the minerals, was also sometimes tinged with yellow, blue, and green. Presently such a tremendous mass of these accumulated clouds stood over Vesuvius as seemed to threaten Naples again, and actually made the mountain itself appear a mole-hill. This day's eruption was similar to that of the 5th, but many degrees more violent

August 11. about six in the morning, the fifth and last fever-fit of the mountain came on, and gradually increased. About 12 o'clock it was at its height, and very violent indeed, the explosions being louder than those that attended the former eruptions. The same mountains of white cotton-like clouds, pilled one over another, rose to such an extraordinary height, and formed such a colossal mass over Vesuvius, as cannot possibly be described, or scarcely imagined. It may have been from a scene of this kind that the ancient poets took their ideas of the giants waging war with Jupiter.

Proceeding to Ottaiano, which is reckoned to contain 12,000 inhabitants, nothing could be more dismal than the sight of this town, unroofed, half buried under black scoriæ and ashes, all the windows towards the mountain broken, and some of the houses themselves burnt, the streets choked up with these ashes; in some that were narrow, the stratum was not less than four feet thick, and a few of the inhabitants just returned were employed in clearing them away, and piling up the ashes in hillocks to get at their ruined houses. The mountain of Somma, at the foot of which Ottaiano is situated, hides Vesuvius from its sight, so that till the eruption became considerable it was not visible to them. On the 8th, when the noise increased, and the fire began to appear above the mountain of Somma, many of the inhabitants of this town flew to the churches, and others were preparing to quit the town, when a sudden violent report was heard; soon after which they found themselves involved in a thick cloud of smoke and minute ashes: a horrid clashing noise was heard in the air, and presently fell a deluge of stones and large scoriæ, some of which scoriæ were of the diameter of seven or eight feet, and must have weighed more than 100 pounds before they were broken by their fall, as some of the fragments of them still

weighed upwards of 60 pounds. When these large vitrified masses either struck against each other in the air, or fell on the ground, they broke in many pieces, and covered a large space around them with vivid sparks of fire, which communicated their heat to every thing that was combustible. In an instant the town and country about it were on fire in many parts; for in the vineyards there were several straw huts, all of which were burnt. A great magazine of wood in the heart of the town was all in a blaze; and had there been much wind the flames must have spread universally, and all the inhabitants would have infallibly been burnt in their houses; for it was impossible for them to stir out. Some who attempted it with pillows, tables, chairs, the tops of wine casks, &c. on their heads, were either knocked down, or soon driven back to their close quarters under arches, and in the cellars of their houses. Had the eruption lasted an hour longer, Ottaiano must have remained exactly in the state of Pompeia, which was buried under the ashes of Vesuvius just 1700 years before, with most of its inhabitants, whose bones are to this day frequently found under arches and in the cellars of the houses of that ancient city.

The number and size of the stones, or, more properly speaking, of the fragments of lava, which were thrown out of the volcano in the course of this eruption, and which lay scattered thick on the cone of Vesuvius, and at the foot of it, were incredible. The largest they measured was in circumference no less than 108 English feet, and 17 feet high. It was a solid block, and much vitrified: in some parts of it there were large pieces of pure glass, of a brown yellow colour, like that of which common bottles are made, and, throughout, its pores seemed to be filled with perfect vitrifications of the same sort. The spot where it fell was plainly marked by a deep impression, almost at the foot of the cone of the volcano; and it took three bounds before it settled, as was plainly perceived by the marks it has left on the ground, and by the stones which it pounded to atoms under a prodigious weight. Another solid block of ancient lava, 66 feet in circumference, and 19 feet high, being nearly of a spherical shape, was thrown out at the same time, and lay near the former.* This stone had the marks of having been rounded, nay almost polished, by continual rolling in torrents, or on the sea-shore; but it had undoubtedly been, in that state, thrown out of the volcano, and may therefore be the subject of curious speculations. Another block of solid lava that was thrown much further, and which lay in the valley between the cone of

Vesuvius and the Hermitage, was 16 feet high, and 92 in circumference, though it appeared, by the large fragments that lay round, and were detached from it by the shock of its fall, that it must have been twice as considerable when in the air. There were thousands of very large fragments of different species of ancient and modern lavas, that lay scattered on the cone of Vesuvius, and in the vallies at its foot; but these three were the largest of those they measured. They measured two other stones in the valley between Somma and Vesuvius; the one was 22½ feet long, 13½ feet broad, and 10 feet high; the other, 11½ feet high, and 72 feet in circumference.

Astronomical Observations relating to the Mountains of the Moon. By Mr. Herschel.

Nov. 30. 1776, six o'clock in the morning, a rock, situated near what Hevelius calls Lacus niger major, was measured to project 41".56. Then, by Hevelius's method, the perpendicular height of the rock is found to be about one mile. The same morning, a great many rocks, situated about the middle of the disk, projected from 25".93 to 26".56. These rocks are all less than half a mile high.

Jan. 13. 1780, seven o'clock, Mr. H. examined the mountains in the moon; but there was not one of them that was fairly placed on level ground, which is a condition very necessary for an exact measurement of the projection. If there should be a declivity on the moon before the mountains, or a tract of hills placed so as to cast a shadow on that part before them which would otherwise be illuminated, it is plain that the projection would appear too large; and, on the contrary, should there be a rising ground before them, it would appear too little. As far as he was able to judge of the direction of the line of illumination, the highest hill projected 26".31: thence we find, as before, that the perpendicular height is less than half a mile.

Jan. 14. 11 o'clock, he took the projection of the highest mountain, which was situated at the western edge. It measured 24".68, or about 27 miles; and the perpendicular height comes out less than half a mile. There was not another mountain in the edge of the disk so high as this. Jan. 17. seven o'clock, a very high mountain projected no less than 40".625. Its situation is in the south-east quadrant; and the perpendicular height of the mountain is 1m.47, or less than a mile and a half.

From these observations, Mr. H. believes it is evident, that

the height of the lunar mountains in general has been greatly over-rated; and that, when we have excepted a few, the generality do not exceed half a mile in their perpendicular elevation.

A Storm of Lightning at East Bourn, Sept. 17. 1780.

About nine in the morning, a black cloud passed over the house of James Adair, Esq., Recorder of London. He saw some shafts of lightning pass from it to the sea, and while standing in the window viewing them, a flash threw him several yards backward on the floor, where he remained some time, sensible, but unable to move, see, or speak. His coat and breeches were torn, and part of the buttons melted. The steel chain of his gold watch was blended with the gold. His flesh on the right side was scorched and torn, and his metal sleeve-button, and his penknife, and a key in his pocket, were partly fused.

Every pane in the window was smashed, and so completely removed, that it did not appear there had been any glass in it, but the frame was little damaged. A pier-glass, and the room-door were shattered in pieces, and the bed-posts in an adjoining room and the bell-wires were destroyed.

In the room below were the coachman, butler, and footman. The coachman was struck dead. His clothes, his wig, and cravat, were much torn, and the enamel face of his watch broken, and the links of the steel chain fixed together.

The footman was also thrown dead on the floor. He was much scorched and bruised, and had a very large wound in his side. His buckskin breeches were much torn, and the steel of a knee-buckle driven through them. The window-sash was driven in.

The butler had a telescope in his hand, which was broken to pieces, and his hat and wig were thrown to some distance, but he was little injured.

A young lady and her maid were in the room over Mr. Adair, and were thrown down and rendered insensible, and the bed-posts and bell-wires were destroyed.

Multitudes on the shore saw the stream or ball strike the house, and resembled it to a sky-rocket.

Account of the Harmattan, a singular African Wind. By Dr. Dobson.

The harmattan is a periodical wind, which blows from the interior parts of Africa towards the Atlantic Ocean. It pre-

vails, at periods, in December, January, and February; over a line of 2000 miles of coast, and comes from the north-east. It is accompanied by a fog, which leaves a dry whiteness, and affords no dew or moisture. It destroys all vegetation, and renders every thing so dry, that the natives then set fire to the high grass to clear the country, and the destruction spreads with frightful rapidity.

The covers of books, and even of a trunk, are shrivelled up. Household furniture is much damaged, and the panels of doors and wainscot are split. The joints of floors open, and ships become leaky. Casks let out their contents, and require constant attention to their hoops.

The eyes, nostrils, lips, and mouth, are rendered dry and uneasy, and the scurf-skin peels off. Salt of tartar remains dry by day and night, and when previously liquefied becomes dry in two or three hours. The evaporation of all moisture is excessive, or four times that in other countries.

Nevertheless it is salubrious to the human constitution. It recovers invalids in many disorders, and stops the progress of epidemics. It is supposed to proceed from some mountains called Caphas, and to be loaded with the arid pulverised dust of the great desert of Sahara. The south-west wind in the Mediterranean, called the Sirocco, is believed to have the same origin. The Fantees, or black natives, divide the year into the names of the prevailing winds, which they call by the names of the stars.

Account of the Termites in Africa, and other hot Climates. By Mr. H. Smeathman.

These ants are called bugga-bugs, wood-lice, white ants, cutters, piercers, eaters, and destructors, in different places. They destroy all timber in buildings, all furniture, and all household stuff and merchandise, and nothing escapes them but metal or stone.

They are called ants, but they do not resemble them in form or changes, only in their large communities and extraordinary nests, constructed with covered galleries, and in their provident labours; but they far surpass our European ants, as well as bees, wasps, beavers, and other animals, in the arts of building, and in sagacity and government.

Their communities consist of one male and one female, who are the common parents of three orders of the insects, which together constitute great commonwealths or monarchies. There are several species, and some build on the ground,

others on the branches of trees, often at great heights. The three orders in each community consist of the labourers, the soldiers, and the winged or perfect insects, which are male and female. From among these latter, kings and queens are elected, which soon emigrate, and found new communities.

The largest species is called *termes bellicosus*, and is best known on the coast of Africa. It erects immense buildings of well attempered clay, with such art and ingenuity as to excite the astonishment of man. In Senegal they resemble the villages of the natives, being 10 or 12 feet above the ground, and like very large hay-cocks. Comparing the size of the animal with that of man, these buildings are four or five times the height of the Monument.

Every building consists of two parts, an exterior dome, and an interior, divided into an amazing number of apartments. The exterior is a protection from the weather, and in the interior reside the king and queen, and the whole community, with magazines stored with provisions and conveniences.

They raise these immense structures in separate turrets, of the shape and size of sugar-loaves, and then fill it between till the dome is completed, by joining the tops of the lofty turrets, which they raise in the centre. Then they take away the bases of the central turrets, and apply the clay to the construction of the interior. The wild bulls stand on them as sentries for the rest of the herd, and men climb up them when they desire to take distant views, and three or four men may stand on a single one.

The royal chamber is in the centre, in the shape of a large oven. Its floor is perfectly horizontal, and its roof a solid and well-turned oval arch. The entrances into it are so small, that the king and queen can never leave it. Around it are numerous apartments for soldiers and attendants, and adjoining are magazines filled with gums and hardened juices of plants of various colours. Among these are the nurseries for eggs and young, built of wood joined by gum, and in vast numbers not more than half an inch in width. At first the nurseries are close to the royal chamber; but as the colony increases, those for attendants are increased, and the nurseries placed at greater distances, in performing which they are continually employed. The whole of the central part is covered with a common roof.

Beneath the whole are common sewers of vast size, even as large as the bore of a cannon, to carry off water, and lined with thick clay: one of them, which was measured, was 13 inches in diameter, descending to the gravel, from the finer parts of

which they make their hard mortar with their mouths. These subterraneous passages are carried horizontally to vast distances, like passages from old castles, from which they emerge on any building or merchandise which they intend to attack. As they cannot carry up perpendiculars, all the ascents and descents are made by spiral roads.

For communication inside, they construct elliptical bridges; and Mr. S. had one 10 inches long, half an inch wide, and a quarter of an inch thick. It was strengthened by a small arch at bottom, and the centre of it was hollowed out for the safety of the passengers.

A smaller species build their city in the shape of an upright CYLINDER, about 27 inches high, and cover it with a roof of the same black earth, like the top of a mushroom, or the roof of a cottage which hangs beyond the walls. When one is too small they build others close to it, and five or six generally stand together

The termes arborum build their nests between the arms and stems of a tree, at the height of 70 or 80 feet, sometimes as large as a sugar hogshead. They are composed of small particles of wood, and the gums and hardened juices of trees, worked by these industrious and interesting little creatures into a paste, and then formed in cells and apartments, in such connection with the tree that nothing can sever them.

The *labourers* among the TERMES BELLICOSUS are about a quarter of an inch long, and 25 of them weigh but a grain. There are about 100 to every soldier: they run faster than any insect of their size, and are always bustling about their affairs The *soldiers* are labourers who have advanced a stage to the winged state. They are half an inch long, and their jaws are adapted for piercing and wounding, being just like two very sharp awls a little jagged; while the mouths of the labourers are calculated only for gnawing and holding. In the third order, they are six or seven tenths of an inch in length, and are furnished with four large, brownish, transparent wings. Their size is equal to that of 30 labourers, or two soldiers, and they have two conspicuous eyes, to aid their search for new dwellings. They* issue in such prodigious numbers, that they become food for birds, other insects, reptiles, and even man, so that not a pair in many millions establishes a new community.

* They become in this state, from being the most active, industrious, fierce, and implacable little animals in the world, the most helpless and cowardly; the prey of other ants, who

are every where seen dragging them to their nests. The few who survive the general massacre of their race are preserved by the labourers of other nests, and by them elected kings and queens of new states. They enclose them in a small chamber of clay, with entrances large enough only for themselves, and become voluntary subjects, taking it on themselves to provide and fight for them, till their own progeny are numerous enough to divide the task with them.

They make pipes of the material of which they build. They thus line most of the roads leading to and from their nests, and pass through woods and over rocks in this secure manner, while, if alarmed, they retreat into their subterraneous passages. The common ant is their most formidable enemy; and as they cannot see, and are soft, while the others are hard, the termes never appear above ground, or out of their covered ways, any accident to which they instantly repair with unwearied industry. If destroyed several times they give it up; but if it be an important road, they soon restore it again. Thus making their approaches under ground, they ascend through the timbers, perforate them completely, and afterwards every wooden part of houses, till they have ruined them. The termes arborum sometimes form their nests in roofs, but more commonly in the trunk of a tree, perforating every part, and destroying every thing within and near it.

They destroy all the softer substances first, and are particularly fond of pine boards, eating away the entire inside, and leaving the surface as thin as paper. A stake in a hedge is their sure prey; of which they leave only the bark, and if the bark fail, or the outside of a beam, they cover it with their mortar, so that no one suspects their attack till the things are handled, or till a support gives way. Fallen trees they perforate in like manner, and what appears to be a sound piece of timber often proves but a shell, which may be crushed between the fingers. They seem aware, that if their work were seen from without they should be disturbed, so that the mischief is never suspected till it is perpetrated. Of deserted houses, or villages, they leave not a vestige in a few weeks.

If any one, from cruel curiosity, make a breach in their hills, a soldier runs out, and walks about the breach, to examine the cause of attack. If he go in to give alarm, two or three come out, who run as fast as they can, and these are followed by a large body. Some of them beat with their forceps on the building, and make a noise like the ticking of a watch, but shriller. If they find the assailant, they fix their hooked jaws in him, and draw blood copiously, and nothing

will remove them. If the attack is given up, the breach will be restored in half an hour, by myriads of labourers, who come every one with a burden of mortar in his mouth. The soldiers retire, except a few, and one, in particular, places himself close to the breach, turning leisurely about, and, at intervals, striking his forceps on the building. A loud hiss then proceeds from the labourers within, and they hasten, and redouble their pace at every such signal. If the attack is renewed the labourers disappear, and the soldiers are instantly out; and if the enemy is quiet they retire again, and the labourers proceed. But no soldier works, nor any labourer remains when defence seems to be necessary.

If the attack is persevered in, the soldiers never desist, and seem to court death, and commonly succeed in driving away negroes without shoes and stockings. Again the labourers barricade every avenue to the interior, and they and the soldiers die voluntary deaths before the royal chamber. If the attack has not reached that chamber, they will block up every avenue, and speedily restore the whole building. If the royal chamber is outraged, the distress and confusion of the poor insects is extreme, and they continue their attentions and loyalty to the last.

One species is the marching termes. These move in regular columns, a soldier directing a body of labourers, and quickening their pace by blows on the ground with his forceps.

Of a Thermometer for measuring the highest Degrees of Heat. By JOSIAH WEDGWOOD.

MR. W. adopted argillaceous earths for his measure. The diminution of their bulk by fire is a distinguishing character of this order of earths. It begins at a low red heat, and proceeds regularly till the clay becomes vitrified, even to a fourth of their dimensions. Of all the sorts, the purest Cornish porcelain clays were the best adapted, both for supporting the intensity and measuring the degrees of fire; the pieces are then put into a brass gauge, wider at one end than the other; and as the piece diminishes in bulk, it slips down the gauge, which is graduated, and determines the contraction and the degree of heat.

The scale commences at a red heat visible in daylight and the greatest heat which Mr. W. could contain in his furnaces was marked 160° by his clay thermometer. Swedish copper melts at 27°, silver at 28°, and gold at 32°. Brass

is in fusion at 21°. The welding heat of iron is 90°, and cast iron melts at 130°: it is fluid at 150°. Glass furnaces are 114° to 124°. Delft ware is fired at 40°, and Queen's ware at 86°: Worcester china vitrified at 94°.

On the proper Motion of the Sun and Solar System among the Stars. By WILLIAM HERSCHEL.

DOES it not seem very natural, says Dr. Herschel, that as there are so many changes among the stars; many increasing their magnitude while others appear to vanish; several of them suspected to be new comers, others that are lost to our sight; the distances of many actually changing, while many more are suspected to have a considerable motion; does it not seem natural that, probably, every star is more or less in motion? Now, if the proper motion of the stars is admitted, who can say that our sun and the solar system is not partaking of the general agitation?

Dr. H. examines the recorded motions of the stars; and in a list of 27 of the principal, he proves that 22 of these motions will be satisfied, if the sun has a proper motion towards the constellation Hercules; and he concludes that the sun and solar system are actually moving towards the star marked *gamma* in Hercules; and that the velocity of the sun is about equal to that of the earth in its orbit.

Account of some late fiery Meteors. By DR. BLAGDEN.

THE first was seen August 18. 1783, as a luminous ball, leaving a train behind, and yielding a prodigious light. It rose in the N. N. W., passed to the east, verged southward, and gradually disappeared. It continued visible about half a minute, and seemed in its course to undergo a change compared to bursting.

It was seen in Shetland, at sea, in the Hebrides, and at Aberdeen and Edinburgh. It proceeded over Yorkshire; and in Lincolnshire deviated to the east, and appeared to burst. It then passed over Cambridgeshire, Suffolk, and Essex, and at Ostend and Calais was considered as vertical. It was also seen at Brussels and Paris, and altogether through a course of 1000 miles. Nothing was more surprising than the brilliant and intense light which it afforded.

A comparison of its elevation in different places proves that it was from 57 to 60 miles in height, where, by theory, the air is 40,000 times more rare than with us; and yet its re-

ports were heard at double the distance, like a volley of small arms, and apparently at the same time in Lincolnshire and Kent. Dr. B. calculates that it was half a mile across, and two miles long, while its train was 10 or 12 times longer than the body. Such an enormous mass, as large as a considerable mountain, moving with such extreme velocity, affords just matter of astonishment.

Its velocity was so great, that it appeared to pass through 1000 or 1200 miles in 40 or 45 seconds, which gives from 20 to 25 miles per second; that is, 100 times more rapid than sound or a cannon ball, and greater than the velocity of the earth in its orbit. Dr. B. concludes it to have been at 20 miles per second, and 90 times greater than sound.

Another meteor was seen on the 4th of October, 1783, smaller than the other. It passed from the northward; but was so rapid, that though Dr. Blagden saw it himself, he could not distinguish whether it passed to or from the S.E. Its height must have been 40 or 50 miles, and its velocity above 12 miles per second.

Dr. B. speculates on the cause and source of these bodies, but a velocity so near that of the earth in its orbit seems to prove that they are unconnected with our globe, and perhaps only become luminous and noisy by passing through our atmosphere.

On the Construction of the Heavens. By Dr. HERSCHEL.

FOR the purpose of viewing the fixed stars, Dr. H. constructed a telescope with a large aperture, so as to increase the light. Its field of view was a quarter of a degree in diameter.

On applying this telescope to the milky-way, it completely resolved the whole into small stars, which his former telescopes had not light enough to effect. He says, "The glorious multitude of stars that presented themselves about the hand and club of Orion was truly astonishing. I found that six fields, promiscuously taken, contained 110, 60, 70, 90, 70, and 74 stars each. A belt of 15 degrees broad, and two wide, or the quantity which I often view in an hour's time, could not contain less than 50,000 stars large enough to be numbered; and I suspect there were twice as many more which I could not see for want of light, though my 20-feet reflector had an aperture of 18¾ inches."

"It is a very remarkable circumstance of the nebulæ and clusters of stars, that they are arranged into strata, which

seem to run on to a great length. The milky-way is undoubtedly nothing but a stratum of fixed stars. It is very probable that this great stratum is that in which our sun is placed, though not in the centre of its thickness, and we seem to be so situated as to view it sideways, and hence its brilliancy. The sun is therefore in this great stratum, and probably not far from the place where some smaller stratum branches out from it. The milky-way is the appearance of the projection of the stars in this stratum, and its secondary branches. By applying ourselves with all our powers to the improvement of telescopes, which I consider as yet in their infant state, we shall in time perhaps be able to delineate the interior construction of the heavens."

"The stupendous sidereal system which we inhabit, this extensive stratum, and its secondary branch, consisting of many millions of stars, is in all probability a detached nebula. In the most crowded parts, I have had fields of view that contained no less than 588 stars, and these have continued for many minutes, so that in a quarter of an hour no less than 116,000 stars passed through the view of my telescope."

"My present telescope will not only reach the stars at 497 times the distance of Sirius, so as to distinguish them, but has also the power of showing the united lustre of the accumulated stars that compose a milky nebulosity at a distance far greater. There are many round nebula of about five or six minutes in diameter, the stars of which I can very distinctly see, the centres of which may be 600 times the distance of Sirius from us, and, from other considerations, perhaps, 6000 times. A nebula which by my telescope is perfectly milky cannot well be supposed to be at less than 6000 or 8000 times the distance of Sirius."

New Experiments on Heat. By Col. Sir B. Thompson, Knt. F.R.S.

Examining the conducting power of air, and of various other fluid and solid bodies, with regard to heat, I was led to examine the conducting power of the Torricellian vacuum. From the striking analogy between the electric fluid and heat, respecting their conductors and non-conductors, (having found that bodies in general, which are conductors of the electric fluid, are likewise good conductors of heat, and, on the contrary, that electric bodies, or such as are bad conductors of the electric fluid, are likewise bad conductors of heat,) I was led to imagine that the Torricellian vacuum, which is known

to afford so ready a passage to the electric fluid, would also have afforded a ready passage to heat. The common experiments of heating and cooling bodies under the receiver of an air-pump I concluded inadequate to determining this question; not only on account of the impossibility of making a perfect void of air by means of the pump; but also on account of the moist vapour which, exhaling from the wet leather and the oil used in the machine, expands under the receiver, and fills it with a watery fluid, which, though extremely rare, is yet capable of conducting a great deal of heat: I had recourse, therefore, to other contrivances.

It appears that the Torricellian vacuum, which affords so ready a passage to the electric fluid, so far from being a good conductor of heat, is a much worse one than common air, which of itself is reckoned among the worst: for, when the bulb of the thermometer was surrounded with air, and the instrument was plunged into boiling water, the mercury rose from 18° to 27° in 15 seconds; but in the former experiment, when it was surrounded by a Torricellian vacuum, it required to remain in the boiling water one minute 30 seconds = 90 seconds, to acquire that degree of heat. In the vacuum it required five minutes to rise to 48°$\frac{2}{10}$; but in air it rose to that height in two minutes 40 seconds; and the proportion of the times in the other observations was nearly the same.

It appears from other experiments, that the conducting power of air to that of the Torricellian vacuum, under the circumstances described, is as 1000 to 702 nearly; for the quantities of heat communicated being equal, the intensity of the communication is as the times inversely.

By others it appears, that the conducting power of air is to that of the Torricellian vacuum as 9$\frac{48}{60}$ to 16$\frac{18}{60}$ inversely, or as 1000 to 603.

Taking now the conducting powers of mercury = 1000, the conducting powers of the other mediums, as determined by these experiments, will be as annexed, viz.

Mercury - - - - - -	1000
Moist air - - - - - -	330
Water - - - - - -	342
Common air, density = 1 - -	8[illegible]
Rarefied air, density = $\frac{1}{4}$ - -	80
Rarefied air, density = $\frac{1}{4}$. - -	78
The Torricellian vacuum - -	55

And in these proportions are the quantities of heat which these different mediums are capable of transmitting in any

given time; and, consequently, these numbers express the relative sensible temperatures of the mediums, as well as their conducting powers.

On the Strata observed in sinking for Water at Boston, Lincolnshire. By Mr. JAMES LAMBIRD, Surveyor to the Corporation.

MAY 7. 1783, George Naylor, of Louth, well-borer, began to bore at the well in the Market-Place, Boston; which had been sunk and bored to the depth of 186 feet from the surface, in 1747, by Thomas Partridge. The well was made about six feet in diameter at the top, five feet at the bottom, and 27 feet deep, and the earth prevented from falling in by a circular frame of wood, which goes from the surface of the earth to the depth of 21 feet six inches, and is there supported by brick-work, laid on a bed of light coloured blue clay, which continues to the depth of 36 feet from the surface, where is a bed of sand and gravel about 18 inches thick, and under it the same sort of blue clay as before, which continues to the depth of 48 feet from the surface. Below this is a bed of dark-coloured stone, like rag-stone, about six inches thick, from under which George Naylor says that a salt spring issues. Beneath this layer of stone is a bed of dark-blue clay, which continues to the depth of 75 feet from the surface, where is a bed of stone, of a lightish colour, about six inches thick, and under it a bed of dark blue clay, which continues to the depth of 114 feet from the surface, where is a bed of stone, of a brightish colour, about eight inches thick, and under it a bed of gravel, about six inches thick, where George Naylor says there is another salt spring. Under the gravel is a bed of dark-coloured clay resembling black-lead, which continues to the depth of 174 feet from the surface, when it changes to a chalky clay, intermixed with small pebbles and flints, which continues about three inches, and then changes to the same kind of dark-coloured clay as before; in which, after boring to the depth of 186 feet from the surface, he came to the solid earth bored to, in 1747, by the above-mentioned Thomas Partridge. After boring in the same kind of clay to the depth of 210 feet from the surface, it changes to a lighter-coloured one, which continues about six inches, and then changes dark again, and continues so to the depth of 342 feet from the surface, where is a bed of shells and white-coloured earth, about half an inch thick, and under it a

light-coloured earth like that at 210 feet from the surface, and under it a bed of dark-coloured clay.

At the distance of 447 feet from the surface there is a bed of dark-coloured earth, mixed with chalk and gravel, which continues to the depth of 449 feet 10 inches from the surface, where is a bed of dark-coloured earth without any chalk and with very little gravel, which continues to the depth of 454 feet seven inches from the surface; there it changes to a dark-coloured earth, mixed with chalk and gravel, which continues to the depth of 456 feet eight inches from the surface, and then changes to a dark-coloured earth without any chalk, and with very little gravel, which continues to the depth of 457 feet from the surface, and then changes to a lighter colour; and this continues to the depth of 462 feet and four inches from the surface, where it changes to a darker colour, and so continues to the depth of 470 feet three inches from the surface. Here the ground changes to a dark-coloured earth, mixed with chalk and gravel, which continues to the depth of 470 feet seven inches from the surface, where he came to a bed of stone, like rag-stone, about 13 inches thick, which ground into powder with the wimble, and mixed with the earth. Under this bed of stone is a dark-coloured earth, without any chalk, and with but little gravel, which continues to the depth of 472 feet from the surface, when it changes something lighter, and continues so about two inches, where the earth appears to be mixed with chalk and gravel, and continues so for about one inch, when it changes to a black silt, having a great deal of light-coloured sand in it.

Of Three Volcanoes in the Moon. By W*M. HERSCHEL, LL.D. F.R.S.*

APRIL 19. 1787, I perceive three volcanoes in different places of the dark part of the new moon. Two of them are either already nearly extinct, or otherwise in a state of approaching eruption; which, perhaps, may be decided next lunation. The third shows an actual eruption of fire, or luminous matter.

April 20. 1787, the volcano burns with greater violence than last night. I believe its diameter cannot be less than 3″, by comparing it with that of the Georgian planet; as Jupiter was near at hand, I turned the telescope to his third satellite, and estimated the diameter of the burning part of the volcano to be equal to at least twice that of the satellite. Hence we may compute that the shining or burning matter

must be above three miles in diameter. It is of an irregular round figure, and very sharply defined on the edges The other two volcanoes are much farther towards the centre of the moon, and resemble large, pretty faint nebulæ, that are gradually much brighter in the middle; but no well defined luminous spot can be discerned in them. These three spots are plainly to be distinguished from the rest of the marks on the moon; for the reflection of the sun's rays from the earth is, in its present situation, sufficiently bright, with a ten-feet reflector, to show the moon's spots, even the darkest of them: nor did I perceive any similar phenomena last lunation, though I then viewed the same places with the same instrument.

The appearance of what I have called the actual fire or eruption of a volcano exactly resembled a small piece of burning charcoal, when it is covered by a very thin coat of white ashes, which frequently adhere to it when it has been some time ignited; and it had a degree of brightness, about as strong as that with which such a coal would be seen to glow in faint daylight. All the adjacent parts of the volcanic mountain seemed to be faintly illuminated by the eruption, and were gradually more obscure as they lay at a greater distance from the crater.

Experiments made to determine the positive and relative Quantities of Moisture absorbed from the Atmosphere by various Substances, under similar Circumstances. By Sir Benj. Thompson, Knt. F. R. S.

Having provided a quantity of each of the under-mentioned substances, in a state of perfect cleanness and purity, says Sir B. T., I exposed them, spread out on clean China plates, 24 hours in the dry air of a very warm room, the last six hours the heat being kept up to 85° of Fahrenheit's thermometer; after which I entered the room with a very accurate balance, and weighed equal quantities of them, as expressed in the following table. Then each substance being equally spread out on a clean China plate, they were removed into a very large uninhabited room on the second floor, where they were exposed 48 hours, on a table placed in the middle of the room, the air of the room being at the temperature of 45° F.; after which they were carefully weighed in the room, and were found to weigh as under mentioned.

They were then removed into a very damp cellar and placed on a table, in the middle of a vault, where the air,

which appeared by the hygrometer to be completely saturated with moisture, was at the temperature of 45° F.; and in this situation they were suffered to remain three days and three nights, the vault being hung round, during all this time, with wet linen cloths, to render the air as damp as possible, and the door of the vault being shut. At the end of the three days I entered the vault, with the balance, and weighed the various substances on the spot, when they were found to weigh as is expressed in the following table:—

The various substances.	Weight after being exposed 48 hours in a cold uninhabited room.	Weight after being exposed 72 hours in a damp cellar.
1000 Parts	Parts.	Parts.
Sheep's-wool - - -	1084	1163
Beaver's fur - - -	1072	1125
The fur of a Russian hare -	1065	1115
Eider down - - -	1067	1112
Silk { Raw, single thread	1057	1107
Silk { Ravelings of white taffety	1054	1103
Linen { Fine lint - -	1046	1102
Linen { Ravelings of fine linen -	1044	1082
Cotton wool - - -	1043	1089
Silver wire, very fine, gilt, and flatted, being the ravelings of gold lace - - -	1000	1000

It is well known, that woollen clothes, such as flannels, &c. worn next the skin, greatly promote insensible perspiration. May not this arise principally from the strong attraction which subsists between wool and the watery vapour which is continually issuing from the human body? That it does not depend entirely on the warmth of that covering is clear; for the same degree of warmth, produced by wearing more clothing of a different kind, does not produce the same effect. The perspiration of the human body being absorbed by a covering of flannel, it is immediately distributed through the whole thickness of that substance, and by that means exposed by a very large surface to be carried off by the atmosphere; and the loss of this watery vapour, which the flannel sustains, on the one side, by evaporation, being immediately restored from the other, in consequence of the strong attraction between the flannel and this vapour, the pores of the skin are disencumbered, and they are continually surrounded by a dry, warm, and salubrious atmosphere.

On the Natural History of the Cuckoo. By Mr. Edward Jenner.

The first appearance of cuckoos in Gloucestershire, the part of England where these observations were made, is about the 17th of April. The song of the male, which is well known, soon proclaims its arrival. The song of the female, if the peculiar notes of which it is composed may be so called, is widely different, and has been so little attended to, that I believe few are acquainted with it. I know not how to convey a proper idea of it by a comparison with the notes of any other bird; but the cry of the dab-chick bears the nearest resemblance to it.

The cuckoo makes choice of the nests of a great variety of small birds. I have known its egg entrusted to the care of the hedge-sparrow, the water-wagtail, the titlark, the yellow hammer, the green linnet, and the whinchat. Among these it generally selects the three former; but shows a much greater partiality to the hedge-sparrow than to any of the rest; therefore, for the purpose of avoiding confusion, this bird only, in the following account, will be considered as the foster-parent of the cuckoo, except in instances which are particularly specified.

The hedge-sparrow commonly takes up four or five days in laying her eggs. During this time, generally after she has laid one or two, the cuckoo contrives to deposit her egg among the rest, leaving the future care of it entirely to the hedge-sparrow. This intrusion often occasions some discomposure; for the old hedge-sparrow, at intervals, while she is sitting, not unfrequently throws out some of her own eggs, and sometimes injures them in such a way that they become addled; so that it more frequently happens, that only two or three hedge-sparrows' eggs are hatched with the cuckoo's, than otherwise: but whether this be the case or not, she sits the same length of time as if no foreign egg had been introduced, the cuckoo's egg requiring no longer incubation than her own. However, I have never seen an instance where the hedge-sparrow has either thrown out or injured the egg of the cuckoo. When the hedge-sparrow has sat her usual time, and disengaged the young cuckoo and some of her own offspring from the shell, her own young ones, and any of her eggs that remain unhatched, are soon turned out, the young cuckoo remaining possessor of the nest, and sole object of her future care. The young birds are not previously killed, nor are the eggs demolished; but all are left to perish

together, either entangled about the bush, which contains the nest, or lying on the ground under it.

A hedge-sparrow built her nest in a hawthorn-bush in a timber-yard: after she had laid two eggs, a cuckoo dropped in a third. The sparrow continued laying, as if nothing had happened, till she had laid five, her usual number, and then sat. On inspecting the nest, June 20. 1786, I found that the bird had hatched this morning, and that every thing but the young cuckoo was thrown out. Under the nest I found one of the young hedge-sparrows dead, and one egg by the side of the nest entangled with the coarse woody materials that formed its outside covering. On examining the egg, I found one end of the shell a little cracked, and could see that the sparrow it contained was yet alive. It was then restored to the nest, but in a few minutes was thrown out. The egg being again suspended by the outside of the nest, was saved a second time from breaking. To see what would happen if the cuckoo was removed, I took out the cuckoo, and placed the egg containing the hedge-sparrow in the nest in its stead. The old birds during this time flew about the spot, showing signs of great anxiety; but when I withdrew they quickly came to the nest again. On looking into it in a quarter of an hour afterwards, I found the young one completely hatched, warm, and lively. The hedge-sparrows were suffered to remain, undisturbed, with their new charge, for three hours, during which time they paid every attention to it, when the cuckoo was again put into the nest. The old sparrows had been so much disturbed by these intrusions, that for some time they showed an unwillingness to come to it: however, at length they came, and on examining the nest again in a few minutes, I found the young sparrow was tumbled out.

June 18. 1787, I examined the nest of a hedge-sparrow, which then contained a cuckoo's and three hedge-sparrows' eggs. On inspecting it the day following, I found the bird had hatched, but that the nest now contained only a young cuckoo and one hedge-sparrow. The nest was placed so near the extremity of a hedge, that I could distinctly see what was going forward in it; and to my astonishment, saw the young cuckoo, though so newly hatched, in the act of turning out the young hedge-sparrow. The mode of accomplishing this was very curious. The little animal, with the assistance of its rump and wings, contrived to get the bird on its back, and making a lodgement for the burden, by elevating its elbows, clambered backward with it up the side of the nest, till it reached the top, where, resting for a moment, it threw off its

load with a jerk, and quite disengaged it from the nest. It remained in this situation a short time, feeling about with the extremities of its wings, as if to be convinced whether the business was properly executed, and then dropped into the nest again. With these, the extremities of its wings, I have often seen it examine, as it were, an egg and nestling before it began its operations; and the nice sensibility which these parts appeared to possess seemed sufficiently to compensate the want of sight, which as yet it was destitute of. I afterwards put in an egg, and this, by a similar process, was conveyed to the edge of the nest and thrown out. These experiments I have since repeated several times in different nests, and have always found the young cuckoo disposed to act in the same manner. In climbing up the nest, it sometimes drops its burden, and thus is foiled in its endeavours; but after a little respite, the work is resumed, and goes on almost incessantly till it is effected. It is wonderful to see the extraordinary exertions of the young cuckoo, when it is two or three days old, if a bird be put into the nest with it that is too weighty for it to lift out. In this state it seems ever restless and uneasy.

Having found that the old hedge-sparrow commonly throws out some of her own eggs after her nest has received the cuckoo's, and not knowing how she might treat her young ones, if the young cuckoo was deprived of the power of dispossessing them of the nest, I made the following experiment: July 9. A young cuckoo, that had been hatched by a hedge-sparrow about four hours, was confined in the nest in such a manner that it could not possibly turn out the young hedge-sparrows which were hatched at the same time; though it was almost incessantly making attempts to effect it. The consequence was, the old birds fed the whole alike, and appeared in every respect to pay the same attention to their own young as to the young cuckoo.

The smallness of the cuckoo's egg, in proportion to the size of the bird, is a circumstance that hitherto, I believe, has escaped the notice of the ornithologist. So great is the disproportion, that it is in general smaller than that of the house-sparrow; whereas the difference in the size of the birds is nearly as five to one. I have used the term in general, because eggs produced at different times by the same bird vary very much in size. I found a cuckoo's egg so light that it weighed only 43 grains, and one so heavy that it weighed 55 grains. The colour of the cuckoo's eggs is extremely variable. Some, both in ground and pencilling, very much re-

semble the house-sparrow's; some are indistinctly covered with bran-coloured spots; and others are marked with lines of black, resembling, in some measure, the eggs of the yellow hammer.

The circumstance of the young cuckoos being destined by nature to throw out the young hedge-sparrows, seems to account for the parent-cuckoo's dropping her egg in the nests of birds so small as those I have particularised. If she were to do this in the nest of a bird which produced a large egg, and, consequently, a large nestling, the young cuckoo would probably find an insurmountable difficulty in solely possessing the nest, as its exertions would be unequal to the labour of turning out the young birds.

It appears a little extraordinary, that two cuckoos' eggs should ever be deposited in the same nest, as the young one produced from one of them must inevitably perish; yet I have known two instances of this kind, one of which I shall relate. June 27. 1787, two cuckoos and a hedge-sparrow were hatched in the same nest this morning; one hedge-sparrow's egg remained unhatched In a few hours after, a contest began between the cuckoos for the possession of the nest, which continued undetermined till the next afternoon, when one of them, which was somewhat superior in size, turned out the other, together with the young hedge-sparrow and the unhatched egg. This contest was very remarkable. The combatants alternately appeared to have the advantage, as each carried the other several times nearly to the top of the nest, and then sunk down again, oppressed by the weight of its burden, till at length, after various efforts, the strongest prevailed, and was afterwards brought up by the hedge-sparrows.

To what cause may we attribute these singularities of the cuckoo? May they not be owing to the following circumstances? The short residence this bird is allowed to make in the country where it is destined to propagate its species, and the call that nature has on it, during that short residence, to produce a numerous progeny. The cuckoo's first appearance here is about the middle of April, commonly on the 17th. Its egg is not ready for incubation till some weeks after its arrival, seldom before the middle of May. A fortnight is taken up by the sitting bird in hatching the egg. The young bird generally continues three weeks in the nest before it flies, and the foster-parents feed it more than five weeks after this period; so that, if a cuckoo should be ready with an egg much sooner than the time pointed out, not a single

nestling, even one of the earliest, would be fit to provide for itself before its parent would be instinctively directed to seek a new residence, and be thus compelled to abandon its young one; for old cuckoos take their final leave of this country the first week in July.

Among the many peculiarities of the young cuckoo, there is one that shows itself very early. Long before it leaves the nest, it frequently, when irritated, assumes the manner of a bird of prey, looks ferocious, throws itself back, and pecks at any thing presented to it with great vehemence, often at the same time making a chuckling noise like a young hawk. Sometimes, when disturbed in a smaller degree, it makes a kind of hissing noise, accompanied with a heaving motion of the whole body. The growth of the young cuckoo is uncommonly rapid. The chirp is plaintive, like that of the hedge-sparrow; but the sound is not acquired from the foster-parent, as it is the same whether it be reared by the hedge-sparrow or any other bird. It never acquires the adult note during its stay in this country.

There seems to be no precise time fixed for the departure of young cuckoos. I believe they go off in succession, probably as soon as they are capable of taking care of themselves; for though they stay here till they become nearly equal in size and growth of plumage to the old cuckoo, yet in this very state the fostering care of the hedge-sparrow is not withdrawn from them. I have frequently seen the young cuckoo of such a size that the hedge-sparrow has perched on its back, or half-expanded wing, in order to gain sufficient elevation to put the food into its mouth. At this advanced stage, I believe that young cuckoos procure some food for themselves; like the young rook, for instance, which in part feeds itself, and is partly fed by the old ones till the approach of the pairing season. If they did not go off in succession, it is probable we should see them in large numbers by the middle of August; for, as they are to be found in great plenty, when in a nestling state, they must now appear very numerous, since all of them must have quitted the nest before this time. But this is not the case; for they are not more numerous at any season than the parent-birds are in the months of May and June.

The same instinctive impulse which directs the cuckoo to deposit her eggs in the nests of other birds directs her young one to throw out the eggs and young of the owner of the nest. The scheme of nature would be incomplete without it; for it would be extremely difficult, if not impossible,

for the little birds, destined to find succour for the cuckoo, to find it also for their own young ones, after a certain period; nor would there be room for the whole to inhabit the nest.

Catalogue of a Thousand of new Nebulæ and Clusters of Stars; with a few introductory Remarks on the Construction of the Heavens. By WM. HERSCHEL, *LL.D. F.R.S.*

THE method I have taken of analysing the heavens, as it were, is perhaps the only one by which we can arrive at a knowledge of their construction. In the prosecution of so extensive an undertaking, it may well be supposed that many things must have been suggested, by the great variety in the order, the size, and the compression of the stars, as they presented themselves to my view.

To begin our investigation according to some order, let us depart from the objects immediately around us to the most remote that our telescopes, of the greatest power to penetrate into space, can reach. From the earth, considered as a planet, and the moon as its satellite, we pass through the region of the rest of the planets, and their satellites. The similarity between all these bodies is sufficiently striking to allow us to comprehend them under one general definition, of bodies not luminous in themselves, revolving round the sun. The great diminution of light, when reflected from such bodies, especially when they are also at a great distance from the light which illuminates them, precludes all possibility of following them a great way into space. This consideration brings us back to the sun, as a refulgent fountain of light, while it establishes, at the same time, beyond a doubt, that every star must likewise be a sun, shining by its own native brightness. Here, then, we come to the more capital parts of the great construction.

These suns, every one of which is probably of as much consequence to a system of planets, satellites, and comets, as our own sun, are now to be considered, in their turn, as the minute parts of a PROPORTIONALLY GREATER WHOLE. By my analysis it appears, that the heavens consist of regions where suns are gathered into separate systems, and that the catalogues I have given comprehend a list of such systems; but may we not hope that our knowledge will not stop short at the bare enumeration of phenomena capable of giving us so much instruction? Why should we be less inquisitive than the natural philosopher, who sometimes, even from an inconsiderable number of specimens of a plant, or an animal, is enabled

to present us with the history of its rise, progress, and decay? Let us then compare together, and class some of these numerous sidereal groups, that we may trace the operations of natural causes as far as we can perceive their agency. The most simple form, in which we can view a sidereal system, is that of being globular. This also, very favourably to our design, is that which has presented itself most frequently, and of which I have given the greatest collection.

But first of all it will be necessary to explain what is our idea of a cluster of stars, and by what means we have obtained it. For an instance, I shall take the phenomenon which presents itself in many clusters: it is that of a number of lucid spots, of equal lustre, scattered over a circular space, in such a manner as to appear gradually more compressed towards the middle; and which compression, in the clusters to which I allude, is generally carried so far as, by imperceptible degrees, to end in a luminous centre, of a resolvable blaze of light. To solve this appearance, it may be conjectured that stars of any given, very unequal magnitudes, may easily be so arranged, in scattered, much extended, irregular rows, as to produce the above-described picture; or, that stars, scattered about almost promiscuously within the frustrum of a given cone, may be assigned of such properly diversified magnitudes as also to form the same picture. But who, that is acquainted with the doctrine of chances, can seriously maintain such improbable conjectures? To consider this only in a very coarse way, let us suppose a cluster to consist of 5000 stars, and that each of them may be put into one of 5000 given places, and have one of 5000 assigned magnitudes. Then, without extending our calculation any further, we have 25,000,000 of chances, out of which only one will answer the above improbable conjecture, while all the rest are against it. When we now remark that this relates only to the given places within the frustrum of a supposed cone, whereas these stars might have been scattered all over the visible space of the heavens; that they might have been scattered, even within the supposed cone, in a million of places different from the assumed ones, the chance of this apparent cluster not being a real one will be rendered so highly improbable that it ought to be entirely rejected.

Mr. Michell computes, with respect to the six brightest stars of the Pleiades only, that the odds are near 500,000 to 1, that no six stars, out of the number of those which are equal in splendour to the faintest of them, scattered at random in the whole heavens, would be within so small a distance from

each other as the Pleiades are. Taking it, then, for granted, that the stars which appear to be gathered together in a group are in reality thus accumulated, I proceed to prove also that they are nearly of an equal magnitude.

The cluster itself, on account of the small angle it subtends to the eye, we must suppose to be very far removed from us. For, were the stars which compose it at the same distance from one another as Sirius is from the sun, and supposing the cluster to be seen under an angle of 10 minutes, and to contain 50 stars in one of its diameters, we should have the mean distance of such stars 12 seconds; and therefore the distance of the cluster from us about 17,000 times greater than the distance of Sirius.

Now, since the apparent magnitude of these stars is equal, and their distance from us is also equal, — because we may safely neglect the diameter of the cluster, which, if the centre be 17,000 times the distance of Sirius from us, will give us 17,025 for the farthest, and 17,000 wanting 25 for the nearest star of the cluster; — it follows, that we must either give up the idea of a cluster, and recur to the above refuted supposition, or admit the equality of the stars that compose these clusters. It is to be remarked, that we do not mean entirely to exclude all variety of size; for the very great distance, and the consequent smallness of the component clustering stars, will not permit us to be extremely precise in the estimation of their magnitudes; though we have certainly seen enough of them to know that they are contained within pretty narrow limits: and do not perhaps exceed each other in magnitude, more than in some such proportion as one full-grown plant of a certain species may exceed another full-grown plant of the same species.

If we have drawn proper conclusions relating to the size of stars, we may with still greater safety speak of their relative situations, and affirm, that in the same distances from the centre an equal scattering takes place. If this were not the case, the appearance of a cluster could not be uniformly increasing in brightness towards the middle, but would appear nebulous in those parts which were more crowded with stars; but, as far as we can distinguish, in the clusters of which we speak, every concentric circle maintains an equal degree of compression, as long as the stars are visible; and when they become too crowded to be distinguished, an equal brightness takes place, at equal distances from the centre, which is the most luminous part.

The next step in my argument will be to show that these

clusters are of a globular form. This again we rest on the sound doctrine of chances. Here, by way of strength to our argument, we may be allowed to take in all round nebulæ, though the reasons we have for believing that they consist of stars have not as yet been entered into. For what I have to say concerning their spherical figure will equally hold good, whether they be groups of stars or not. In my catalogues we have, I suppose, not less than 1000 of these round objects. Now, whatever may be the shape of a group of stars, or of a nebula, which we would introduce instead of the spherical one, such as a cone, an ellipsis, a spheroid, a circle or a cylinder, it will be evident that out of 1000 situations, which the axes of such forms may have, there is but one that can answer the phenomenon for which we want to account; and that is, when those axes are exactly in a line drawn from the object to the place of the observer. Here, again, we have 1,000,000 of chances, of which all but one are against any other hypothesis than that which we maintain, and which, for this reason, ought to be admitted.

The last thing to be inferred from the above-related appearances is, that these clusters of stars are more condensed towards the centre than at the surface. If there should be a group of stars in a spherical form, consisting of such as were equally scattered over all the assigned space, it would not appear to be very gradually more compressed and brighter in the middle, much less would it seem to have a bright nucleus in the centre. A spherical cluster of an equal compression within, — for that such there are will be seen hereafter, — may be distinguished by the degrees of brightness which take place in going from the centre to the circumference. Now as a gradual increase of brightness does not agree with the degrees calculated from a supposition of an equal scattering, and as the cluster has been proved to be spherical, it must needs be admitted that there is indeed a greater accumulation towards the centre. And thus, from the above-mentioned appearances, we come to know that there are globular clusters of stars nearly equal in size, which are scattered evenly at equal distances from the middle, but with an increasing accumulation towards the centre. The formation of round clusters of stars and nebulæ is either owing to central powers, or at least to one such force as refers to a centre. Since, then, almost all the nebulæ and clusters of stars I have seen, the number of which is not less than 2300, are more condensed and brighter in the middle; and since, from every form, it is now equally apparent that the central accumulation

or brightness must be the result of central powers, we may venture to affirm that this theory is no longer an unfounded hypothesis, but is fully established on grounds which cannot be overturned.

Some of these round clusters consist of stars of a certain magnitude, and given degree of compression, while the whole cluster itself takes up a space of perhaps 10 minutes; others appear to be made up of stars that are much smaller, and much more compressed, when at the same time the cluster itself subtends a much smaller angle, such as 5 minutes. This diminution of the apparent size, and compression of stars, as well as diameter of the cluster to four, three, two minutes, may very consistently be ascribed to the different distances of these clusters from the place in which we observe them; in all which cases we may admit a general equality of the sizes, and compression of the stars that compose them, to take place. Other clusters there are that, when they come to be compared with some of the former, seem to contain stars of an equal magnitude, while their compression appears to be considerably different.

This method of viewing the heavens seems to throw them into a new kind of light. They now are seen to resemble a luxuriant garden, which contains the greatest variety of productions, in different flourishing beds; and one advantage we may at least reap from it is, that we can, as it were, extend the range of our experience to an immense duration. For, to continue the simile I have borrowed from the vegetable kingdom, is it not almost the same thing, whether we live successively to witness the germination, blooming, foliage, fecundity, fading, withering, and corruption of a plant, or whether a vast number of specimens, selected from every stage through which the plant passes in the course of its existence, be brought at once to our view?

Dr. H. then adds the catalogue of the 1000 new nebulæ and clusters of stars: the numbers, dates of observation, names, situations, and several other characteristic circumstances, are arranged in eight columns of a table, which is divided into eight classes or collections:—The first class is of such as are entitled, from their appearance in the heavens, bright nebulæ; the second class are the faint nebulæ; the third class, the very faint nebulæ; the fourth class, planetary nebulæ; the fifth class, very large nebulæ; the sixth class, very compressed, and clusters of stars; the seventh class, pretty much compressed clusters of large or small stars; and the eighth, or last class, coarsely scattered clusters of stars.

Discovery of a sixth and seventh Satellite of the Planet Saturn; with Remarks on the Construction of its Ring, its Atmosphere, its Rotation on an Axis, and its Spheroidical Figure. By WM. HERSCHEL, *LL.D. F.R.S.*

HE presents an account of two new satellites, which he discovered by means of his large 40-foot telescope; and has called them the sixth and seventh, though their situation in the Saturnian system entitles them to the first and second place.

The planet Saturn is, perhaps, one of the most engaging objects that astronomy offers to our view. He observes, that the black disk, or belt, on the ring of Saturn, is not in the middle of its breadth; nor is the ring subdivided by many such lines, as has been represented in divers treatises of astronomy; but that there is one single, dark, considerably broad line, belt, or zone, on the ring, which he always permanently found in the same place. From his observations it appears, that the zone on the northern plane of the ring is not, like the belts of Jupiter or those of Saturn, subject to variations of colour and figure; but is most probably owing to some permanent construction of the surface of the ring itself. That, however, for instance, this black belt cannot be the shadow of a chain of mountains, may be gathered from its being visible all round on the ring; for at the ends of the ansæ there could be no shades visible, on account of the direction of the sun's illumination, which would be in the line of the chain; and the same argument will hold good against supposed caverns or concavities. It is also pretty evident, that this dark zone is contained between two concentric circles, as all the phenomena answer to the projection of such a zone. Thus, the zone is continued all round the ring, with a gradual decrease of breadth towards the middle answering to the appearance of a narrow circular plane, projected into an ellipsis.

With regard to the nature of the ring, we may certainly affirm, that it is no less solid and substantial than the planet itself. The same reasons which prove to us the solidity of the one will be full as valid when applied to the other. Thus we see the shadow of the body of Saturn on the ring. In the same manner we see the shadow of the ring cast on the planet. If we deduce the quantity of matter contained in the body, from the power by which the satellites are kept in their orbits, and the time of their revolution, it must be remembered, that the ring is included in the result. It is also in a very particular manner evident, that the ring exerts a considerable force on

these revolving bodies, since we find them strongly affected with many irregularities in their motions, which we cannot properly ascribe to any other cause than the quantity of matter contained in the ring; at least we ought to allow it a proper share in the effect, as we do not deny but that the considerable equatorial elevation of Saturn must also join in it.

The light of the ring of Saturn is generally brighter than that of the planet: for instance, the southern part of the ring, which passed before the body, was seen very plainly brighter than the disk of Saturn, on which it was projected.

Dr. H. comes now to one of the most remarkable properties in the construction of the ring, which is its extreme thinness. When nearly in the plane of the ring, he repeatedly saw the first, the second, and the third satellites, nay even the sixth and seventh, pass before and behind the ring in such a manner that they served as excellent micrometers to estimate its thickness by. July 18. 1789, the first satellite seemed to hang on the following arm, declining a little towards the north, and gradually advanced on it towards the body of Saturn; but the ring was not so thick as the lucid point.

April 9. 1775, Dr. H. observed a northern belt on Saturn, which was a little inclined to the line of the ring. May 1. 1776, there was another belt, inclined about 15° to the same line, but it was more to the south, and on the following side came up to the place in which the ring crosses the body. July 13. the belt was again depressed towards the north, almost touching the line where the ring passed behind the body. April 8. 1777, there were two fine belts, both a little inclined to the ring.

We may draw two conclusions from what has been reported. The first, which relates to the changes in the appearance of the belts, is, that Saturn has probably a very considerable atmosphere, in which these changes take place; just as the alterations in the belts of Jupiter have been shown, with great probability, to be in his atmosphere. The next inference we may draw from the appearance of the belts on Saturn is, that this planet turns on an axis, which is perpendicular to the ring.

There is another argument, of equal validity with the former, which Dr. H. now mentions. It is founded on the following observations, and will show that Saturn, like Jupiter, Mars, and the Earth, is flattened at the poles, and therefore ought to be supposed to turn on its axis. It appears that Saturn is considerably flattened at the poles. And as the greatest measures were taken in the line of the ring and of

the belts, we are assured that the axis of the planet is perpendicular to the plane of the ring, and that the equatorial diameter is to the polar nearly as 11 to 10.

Observations on the Sugar-Ants. By JOHN CASTLES, *Esq.*

THE sugar-ants, so called from their ruinous effects on the sugar-cane, first made their appearance in Grenada about the year 1770. Thence they continued to extend themselves on all sides, for several years; destroying, in succession, every sugar-plantation between St. George's and St. John's, a space of about 12 miles.

All attempts of the planters to put a stop to the ravages of these insects having been found ineffectual, it well became the legislature to offer great public rewards for discovering a practicable method of destroying them, so as to permit the cultivation of the sugar-cane as formerly. Accordingly, an act was passed, by which such discoverer was entitled to 20,000*l.*, to be paid from the public treasury of the island. In Grenada there had always been several species of ants, differing in size, colour, &c. which, however, were perfectly innocent with respect to the sugar-cane. The ants in question, on the contrary, were not only highly injurious to it, but to several sorts of trees, such as the lime, lemon, orange, &c.

Their numbers were incredible. The roads are seen coloured by them for miles together; and so crowded were they in many places, that the print of the horses' feet would appear for a moment or two, till filled up by the surrounding multitude. All the other species of ants, though numerous, were circumscribed and confined to a small spot, in proportion to the space occupied by the cane-ants, as a mole-hill to a mountain. The common black ants of that country had their nests about the foundation of houses or old walls; others in hollow trees; and a large species in the pastures, descending by a small aperture under ground. The sugar-ants universally constructed their nests among the roots of particular plants and trees, such as the sugar-cane, lime, lemon and orange trees, &c.

The use of fire afforded a great probability of success; for it was observed, that if wood, burnt to the state of charcoal, without flame, and immediately taken from the fire, was laid in their way, they crowded to it in such amazing numbers as soon to extinguish it, though with the destruction of thousands of them in effecting it. This part of their history

appears scarcely credible; but, on making the experiment himself, Mr. C. found it literally true. He laid fire, as above described, where there appeared but a very few ants, and in the course of a few minutes thousands were seen crowding to it and on it, till it was perfectly covered by their dead bodies. Holes were therefore dug at proper distances in a cane-piece, and fire made in each of them. Prodigious quantities perished in this way; for those fires, when extinguished, appeared in the shape of mole-hills, from the numbers of their dead bodies heaped on them. Yet they soon appeared again as numerous as ever.

This calamity, which resisted so long the efforts of the planters, was at length removed by another, which, however ruinous to the other islands in the West Indies, and in other respects, was to Grenada a very great blessing, namely, the hurricane in 1780. These ants make their nests, or cells for the reception of their eggs, only under or among the roots of such trees or plants as are not only capable of protecting them from heavy rains, but are at the same time so firm in the ground as to afford a secure basis to support them against any injury occasioned by the agitation of the usual winds. This double qualification the sugar-cane possesses in a very great degree; for a stool of canes, which is the assemblage of its numerous roots where the stems begin to shoot out, is almost impenetrable to rain, and is also, from the amazing numbers and extension of the roots, firmly fixed to the ground.—At Duquesne, particularly at that time, they were pernicious in the highest degree, spreading themselves on all sides with great rapidity, when a sudden stop was put to their progress by the hurricane which happened near the middle of October that year.

When by the violence of the tempest heavy pieces of artillery were removed from their places, and houses and sugar-works levelled with the ground, there can be no doubt that trees and every thing growing above ground must have greatly suffered. This was the case. Great numbers of trees and plants, which resist commonly the ordinary winds, were torn out by the root. The canes were universally either lodged or twisted about as if by a whirlwind, or torn out of the ground altogether. In the latter case, the breeding ants, with their progeny, must have been exposed to inevitable destruction from the deluge of rain which fell at the same time. The number of canes, however, thus torn out of the ground, could not have been adequate to the sudden diminution of the sugar-ants, but it is easy to conceive that

the roots of canes which remained on the ground, and the earth about them, were so agitated and shaken, and at the same time the ants' nests were so broken open, or injured by the violence of the wind, as to admit the torrents of rain accompanying it. Probably, therefore, the principal destruction of these ants must have been thus effected.

On Basaltes and Granite. By THOS. BEDDOES, M.D.

ALL our opinions on the formation of rocks and mountains, except volcanic mountains, must of necessity rest on analogical reasoning, since we have no direct testimony concerning their origin. Hence, whatever portion of the mineral kingdom is but little connected with our experience of the action of fire or water must be slightly passed over. Basaltes has been much more the subject of disputation than granite; the former species of rock offering appearances that coincide in some degree with both kinds of chemical processes, while the latter seems to stand aloof from the experiments that have given birth to our sciences.

Under the term basaltes he comprehends that vast natural family of rocks which is frequently cracked into regular colonnades, and may be followed in an unbroken series from this perfect form, through endless modifications, to the most shapeless mass of trap or whinstone. Though frequently of an iron-grey colour and uniform texture, this species of stone varies greatly in both these characters, even in the same rock. In particular, it passes, by the most insensible gradations, both to the porphyries with which it coincides in appearance, in composition, and doubless also in origin, and to the hornstein of the Germans; a term including petrosilex and several sorts of close-grained whinstone, of which there are found in England varieties with a conchoidal fracture, semi-transparent at the edges, and in other respects fast approaching to a siliceous nature. The first step in the progression appears at the Giants' Causeway in Ireland. Many of the pillars there consist of fine-grained, dark-coloured whinstone; that variety which may be considered as most perfect, and as equidistant from porphyry, petrosilex, and granite: but at the promontory of Fairhead the character of the stone is seen to alter, and it has lately been described as an imperfect kind of granite. Hence we are led by regular approaches to perfect prisms of granite, accompanied by prisms of common whinstone, and not less obviously than the different ranges on the coast of Antrim betraying a common origin.

Attempts have been made to set up boundaries between the columnar granite of the Euganean hills, the granite of the volcanic provinces of France, the granitello of the Italians, and such granite as is found to constitute high and extensive ranges of mountains. As to a difference in the size of particles, and hardness of the stone, the first distinction is neither constant, nor by any means calculated to persuade us that a cause, capable of producing the one, is inadequate to the production of the other. It may probably be explained from the quantity of matter, more or less perfect fusion, a different length of time in cooling; and, in the latter character, he suspects the observers to have been deceived by the decay of the rocks they inspected. At all events, lavas in abundance show, that fire is capable of producing any required degree of compactness.

By observations like these, which the specimens Dr. B. either possesses or has examined corroborate and complete, he is persuaded, that when once it becomes an object of attention, persons who have an opportunity of exploring countries where basaltes and granite abound, will easily find a succession of specimens beginning at the former and terminating at the latter. Nor is it, perhaps, difficult to assign highly probable reasons, why a mixture of different earths with more or less of metallic matter, in returning from a state of fusion to a solid consistence, may assume sometimes the homogeneous basaltic, and sometimes the heterogeneous granitic internal structure. No fact is more familiar than that it depends altogether on the management of the fire, and the time of cooling, whether a mass shall have the uniform vitreous fracture, or an earthy broken grain, arising from a confused crystallisation. The art of making Reaumur's porcelain consists entirely in allowing the black glass time to crystallise by a slow refrigeration; and the very same mass, according as the heat is conducted, may, without any alteration of its chemical constitution, be successively exhibited any number of times as glass, or as a stony matter with a broken grain. In the slag of the iron furnaces the same piece generally exhibits both these appearances: the upper surface cools fast, and is glass; what lies deeper loses its heat more gradually, and is allowed time to take on the crystalline arrangement peculiar to its nature, in as far as a number of crystals, starting from various points at once, and crowding each other, will admit of it.

In the natural history of granite and basaltes, another striking circumstance occurs: they lie so contiguous, and are

so involved in each other, that we cannot but suppose both to have undergone the same operations of nature at the same time. This is seen with the utmost frequency on every possible scale, and under a vast variety of modifications. Experiments show, that almost all granites melt into a black glass; and, perhaps, it is no abuse of analogy, nor inconsistent with what has been already remarked, to conclude, that granite, in the state of imperfect fusion, should present a glassy substance, involving the more infusible parts of which this stone consists.

In the whinstone rocks of England, which are far more numerous than is commonly supposed, Dr. B. has often observed in the same hill, 1. homogeneous dark-grey stone; 2. feldspath inclosed in this as in a paste; and, 3. the paste disappearing, and the whole becoming granular, and the grains heterogeneous. Besides feldspath, quartz is found in innumerable masses of varying magnitude in many whinstone rocks; and as proper basaltes is but a confused mass of crystals of shoerl, we have all the ingredients of granite; and why may we not expect to find them incorporated together, and in every state of diffusion and separation?

There is still another analogy between basaltes and granite, more important to the theory of the earth, and less liable to controversy than either of the preceding. In their situation, with respect to other rocks, we may observe the same law. The general rule of super-position, reckoning from below upwards, is, 1. granite; 2. schistus; 3. lime-stone. This rule has been found to hold good by so many mineralogical travellers, that, though it may not be absolutely universal, it must be allowed to prevail very extensively. Now, in this island there are numerous instances where basaltes is substituted in the series instead of granite, and where it seems to alternate with granite as the substratum of other rocks. On the road from Dolgelly in Merionethshire, by Mallwhyd and Cann's Office, through Llanfair to Welchpool, schistus appears always incumbent on whinstone, except sometimes when the latter is interjected between the strata, or squeezed up through fissures. In Wales the country is so hilly, that the limestone, if it existed, has probably been washed away; but on the confines of England it comes in. The road from Welchpool to Shrewsbury passes over the side of the Long Mountain, which consists of schistus; on the left, or towards the east, rise some considerable basaltic hills. The strata of the Long Mountain point towards the summit of these hills, as if the narrow valley that intervenes had been cut by water on the lifted edge

of the schistus. At a small distance from the north and south sides of the basaltic hills calcareous strata are found. Beyond Shrewsbury, on the road to London, we have, instead of the continued ridges of Wales, a number of insulated, and generally rugged, points, rising over the face of Shropshire and the adjacent counties. Were the plains covered with water a few yards in depth, these eminences would appear from distance to distance like so many stepping stones. They all, except the Malvern Hills, which, though composed of granite, he considers as part of the same system, consist of whinstone. Among these stepping stones he reckons the basaltic hills near Welchpool, the Wrekin, Lilleshall Hill, and, at a greater distance towards the east, the rising grounds near Newcastle in Staffordshire, whence the whin-rock perhaps communicates by the toadstone of Derbyshire, through the hills in the north of England with the whinstone towards the south of Scotland. In a south or south-west direction from the Wrekin, a number of craggy eminences arise. They are basaltes, and form a striking contrast with the smooth, rounded, and lumpish swells of schistus in their neighbourhood. From the whin rocks near Stretton, we may pass by the Brown and Titterstone Clee Hills (on the latter of which are regular prismatic columns) to the Malvern Hills. About these hills lie strata of schistus and limestone, as is seen on the road from Much Wenlock to Stretton. To the south-east an extensive field of whinstone, with occasional elevations, is spread over the confines of Worcestershire, Warwickshire, and Staffordshire. Here we have the Rowley ragstone. Whether the basaltes proceeds southward by such interruptions till it join the Elvin or whinstone, and granite of Devonshire and Cornwall, where, probably, they may be found incorporated, he wishes for an opportunity to examine. In the plain part of this whole district, the whin-rock appears often at the surface, or a little below the strata, so that the hills have probably a subterraneous communication with each other, and there needed but a little more lifting force to form continued ranges of mountains. The road from Welchpool to Birmingham, above 60 miles is repaired in a great measure with whinstone. A colonnade of basaltes has been lately exposed in digging the Shropshire canal: and in the mining country around levels have been driven in the black rock, as it is sometimes called. As whinstone and slate are seen in various other parts of North and South Wales, the whole western side of our island has probably been raised by the basaltes on which the superficial strata now rest, though from particular circumstances

the fused mass has now and then crystallised into granite; and as it has been conjectured, that the basaltes of Ireland once joined that of the Scotch isles and the main land itself, so perhaps the basaltes of North Wales joined the Irish coast till the sea worked its way or broke in, and destroyed the continuation. As limestone is sometimes said to rest immediately on granite, so at the foot of the Wrekin, and at Lilleshall Hill, no slate is interposed between the limestone and basaltes; so that the analogy extends even to the exceptions.

One consequence of these observations is too important to be omitted. They lead us to reject the common division of mountains into primary and secondary. The chains of granite, schistus, and limestone, must be all coeval; for if the central chain of the Alps burst as a body expanded by heat from the bowels of the earth, it reared the bordering chains at the same effort. But it must be recollected, that the mountains no longer wear their original form, vallies having been cut between and through them, and various other effects of dilapidation having taken place. It is by no means difficult to understand why no exuviæ of organised bodies are found in these imaginary primitive mountains. Rising from a great depth, they threw aside the superficial accumulations of the ancient ocean. What was deepest is therefore now most central; and what lay on the surface now skirts the high interior chains. Hence the strata rest indifferently on granite, basaltes, or lava; all which substances derive from their situation an equal claim to be regarded as primordial materials.

On Nebulous Stars, properly so called. By Wm. Herschel, LL.D. F.R.S.

In one of his late examinations of a space in the heavens, which he had not reviewed before, Dr. H. discovered a star of about the eighth magnitude, surrounded with a faintly luminous atmosphere, of a considerable extent. The phenomenon was so striking that he could not help reflecting on the circumstances that attended it, which appeared to be of a very instructive nature, and such as might lead to inferences which will throw a considerable light on some points relating to the construction of the heavens. Cloudy or nebulous stars have been mentioned by several astronomers; but this name ought not to be applied to the objects which they have pointed out as such; for, on examination, they proved to be either mere clusters of stars, plainly to be distinguished with his

large instruments, or such nebulous appearances as might be reasonably supposed to be occasioned by a multitude of stars at a vast distance.

The milky way itself consists entirely of stars, and by imperceptible degrees he was led on from the most evident congeries of stars to other groups in which the lucid points were smaller, but still very plainly to be seen; and from them to such wherein they could but barely be suspected, till he arrived at last to spots in which no trace of a star was to be discerned. But then the gradations to these latter were by such well-connected steps as left no room for doubt but that all these phenomena were equally occasioned by stars, variously dispersed in the immense expanse of the universe.

When Dr. H. pursued these researches, he was in the situation of a natural philosopher, who follows the various species of animals and insects, from the height of their perfection down to the lowest ebb of life; when, arriving at the vegetable kingdom, he can scarcely point out to us the precise boundary where the animal ceases and the plant begins; and may even go so far as to suspect them not to be essentially different. But recollecting himself, he compares, for instance, one of the human species to a tree, and all doubt on the subject vanishes before him. In the same manner we pass through gentle steps from a coarse cluster of stars, such as the Pleiades, the Præsepe, the milky way, the cluster in the Crab, the nebula in Hercules, that near the preceding hip of Bootes, till we find ourselves brought to an object such as the nebula in Orion, where we are still inclined to remain in the once adopted idea, of stars exceedingly remote, and inconceivably crowded, as being the occasion of that remarkable appearance. It seems, therefore, to require a more dissimilar object to set us right again. A glance like that of the naturalist, who casts his eye from the perfect animal to the perfect vegetable, is wanting to remove the veil from the mind of the astronomer. The object mentioned above is the phenomenon that was wanting for this purpose. Our judgment will be, that the nebulosity about the star is not of a starry nature.

A well connected series of objects, such as mentioned above, has led us to infer, that all nebulæ consist of stars. This being admitted, we were authorised to extend our analogical way of reasoning a little further. Many of the nebulæ had no other appearance than that whitish cloudiness on the blue ground on which they seemed to be projected; and why the same cause should not be assigned to explain the most extensive nebulosities, as well as those that amounted

only to a few minutes of a degree in size, did not appear It could not be inconsistent to call up a telescopic milky way, at an immense distance, to account for such phenomena; and if any part of the nebulosity seemed detached from the rest, or contained a visible star or two, the probability of seeing a few near stars, apparently scattered over the far distant regions of myriads of sidereal collections, rendered nebulous by their distance, would also clear up these singularities.

When Dr. H. examined the cluster of stars, following the head of the Great Dog, he found, on March 19. 1786, that there was within this cluster a round, resolvable nebula, of about two minutes in diameter, and nearly of an equal degree of light throughout. Here, considering that the cluster was free from nebulosity in other parts, and that many such clusters, as well as many such nebulæ, exist in divers parts of the heavens, it appeared very probable, that the nebula was unconnected with the cluster, and a casual situation of our sun and the two other objects being nearly in a line. And though it may be rather more remarkable, that this should happen with two compound systems, which are not by far so numerous as single stars, we have, to make up for this singularity, a much larger space in which it may take place, the cluster being of a very considerable extent.

There is a telescopic milky way, which Dr. H. has traced out in the heavens in many sweeps, made from the year 1783 to 1789. It takes up a space of more than 60 square degrees of the heavens, and there are thousands of stars scattered over it: among others, four that form a trapezium, and are situated in the well-known nebula of Orion, which is included in the above extent. All these stars, as well as the four mentioned, he takes to be entirely unconnected with the nebulosity which involves them in appearance. Among them is also *d* Orionis, a cloudy star, improperly so called by former astronomers; but it does not seem to be connected with the milkiness any more than the rest.

Nov. 13. 1790. A most singular phenomenon! A star of about the eighth magnitude, with a faint luminous atmosphere, of a circular form, and of about three minutes in diameter. The star is perfectly in the centre, and the atmosphere is so diluted, faint, and equal throughout, that there can be no surmise of its consisting of stars; nor can there be a doubt of the evident connection between the atmosphere and the star. Another star, not much less in brightness, and in the same field with the above, was perfectly free from any such appearance. This last object is so decisive in every par-

ticular, Dr. H. says, that we need not hesitate to admit it as a pattern, from which we are authorised to draw the following important consequences: —

Supposing the connection between the star and its surrounding nebulosity to be allowed, we argue, that one of the two following cases must necessarily be admitted. In the first place, if the nebulosity consist of stars that are very remote, which appear nebulous on account of the small angles, their mutual distances subtend at the eye, by which they will not only, as it were, run into each other, but also appear extremely faint and diluted; then what must be the enormous size of the central point, which outshines all the rest in so superlative a degree as to admit of no comparison? In the next place, if the star be no larger than common, how very small and compressed must be those other luminous points that are the occasion of the nebulosity which surrounds the central one? As, by the former supposition, the luminous central point must far exceed the standard of what we call a star, so, in the latter, the shining matter about the centre will be much too small to come under the same denomination; we, therefore, either have a central body which is not a star, or have a star which is involved in a shining fluid, of a nature totally unknown to us. Dr. H. can adopt no other sentiment than the latter, since the probability is certainly not for the existence of so enormous a body as would be required to shine like a star of the eighth magnitude, at a distance sufficiently great to cause a vast system of stars to put on the appearance of a very diluted, milky nebulosity.

But what a field of novelty is here opened to our conceptions! A shining fluid, of a brightness sufficient to reach us from the remote regions of a star of the eighth, ninth, tenth, eleventh, or twelfth magnitude, and of an extent so considerable as to take up three, four, five, or six minutes in diameter! Can we compare it to the coruscation of the electrical fluid in the aurora borealis? Or to the more magnificent cone of the zodiacal light, as we see it in spring or autumn?

More extensive views may be derived from this proof of the existence of a shining matter. Perhaps it has been too hastily surmised that all milky nebulosity, of which there is so much in the heavens, is owing to starlight only. These nebulous stars may serve as a clue to unravel other mysterious phenomena. If the shining fluid that surrounds them is not so essentially connected with these nebulous stars, but that it can also exist without them, which seems to be sufficiently probable, and will be examined hereafter, we may

with great facility explain that very extensive, telescopic nebulosity, which, as before mentioned, is expanded over more than 60° of the heavens, about the constellation of Orion; a luminous matter accounting much better for it than clustering stars at a distance.

It has been said above, that in nebulous stars the existence of the shining fluid does not seem to be so essentially connected with the central points that it might not also exist without them. For this opinion we may assign several reasons. One of them is the great resemblance between the chevelure of these stars and the diffused extensive nebulosity mentioned before, which renders it highly probable that they are of the same nature. Now, if this be admitted, the separate existence of the luminous matter, or its independence on a central star, is fully proved. We may also judge, very confidently, that the light of this shining fluid is no kind of reflection from the star in the centre; for reflected light could never reach us at the great distance we are from such objects. Besides, how impenetrable would be an atmosphere of a sufficient density to reflect so great a quantity of light? And yet we observe, that the outward parts of the chevelure are nearly as bright as those that are close to the star; so that this supposed atmosphere ought to give no obstruction to the passage of the central rays. If, therefore, this matter is self-luminous, it seems more fit to produce a star by its condensation than to depend on the star for its existence.

How far the light that is perpetually emitted from millions of suns may be concerned in this shining fluid, it might be presumptuous to attempt to determine; but, notwithstanding the unconceivable subtilty of the particles of light, when the number of the emitting bodies is almost infinitely great, and the time of the continual emission indefinitely long, the quantity of emitted particles may well become adequate to the constitution of a shining fluid, or luminous matter, provided a cause can be found that may retain them from flying off, or re-unite them. But such a cause cannot be difficult to guess at, when we know that light is so easily reflected, refracted, inflected, and deflected; and that, in the immense range of its course, it must pass through innumerable systems, where it cannot but frequently meet with many obstacles to its rectilinear progression.

On the Decomposition of fixed Air. By SMITHSON TENNANT, *Esq. F. R. S.*

As fixed air is produced by the combustion of charcoal, it has long been thought highly probable that vital air and charcoal are its constituent ingredients. This opinion is confirmed by the experiments of Lavoisier, from which he discovered that the weight of the fixed air which is formed during the combustion is nearly equal to that of the vital air and charcoal consumed in the process; and that the small difference of weight may, with great reason, be attributed to the production of water arising from inflammable air contained in the charcoal. The composition of fixed air, therefore, seems to be determined, by uniting its constituent parts, with as much certainty as by that mode of proof alone it is possible to obtain. But as vital air has a stronger attraction for charcoal than for any other known substance, the decomposition of fixed air has not hitherto been attempted. By means, however, of the united force of two attractions, Mr. T. has been able to decompose fixed air, and thus to determine its constituent parts in consequence of their separation.

Charcoal, thus obtained from fixed air, appears in no respect to differ from the charcoal of vegetable matters. On deflagrating a little of it in a small retort with nitre, fixed air was immediately reproduced. Since, therefore, charcoal, by its separation from fixed air, is proved to be one of its constituent principles, it can hardly be doubted that this substance is present whenever fixed air is produced; and that those experiments, from which it is supposed that this acid may be formed without the aid of charcoal, have not been conducted with the requisite caution.

On the Ring of Saturn. By WM. HERSCHEL, *LL.D. F.R.S.*

IT is well known to astronomers that the ring of Saturn becomes alternately enlightened on one of its sides, and that this change of illumination takes place when the planet passes through the node of the ring. This happened in October, 1789, when the southern plane, which had been in the dark for about 15 years, became visible to us. And since Dr. H. had a great number of fine views of the ring of Saturn, he here delivers as many of the observations as will be sufficient to throw light enough on the subject, to enable us to decide the question, whether this ring be double or single?

Observations on the Ring of Saturn.—Sept. 7. 1790; 20-feet

reflector. No dark division can as yet be seen on the ring of Saturn; but it is hardly open enough to expect it to be visible. — Aug. 5. 1791; 20-feet reflector. The black list, on this side of the ring of Saturn, is exactly in the same relative place where it was seen on the northern plane. — Sept. 25. 1791; 20-feet reflector. The black division goes all around the ring, as far as he can trace it, exactly in the same place where he used to see it on the north side. — Oct. 13. 1791; 10-feet reflector. The black division on the southern plane of Saturn's ring is in the same place, of the same breadth, and at the same distance from the outer edge, that he had always seen it on the northern plane. With a power of 400, he saw it very distinctly: it is of the same kind of colour as the space between the ring and the body, but not so dark. — Oct. 24. 1791; seven-feet reflector. With a new machine-polished, most excellent speculum, he saw that the division on the ring of Saturn, and the open spaces between the ring and the body, are equally dark, and of the same colour with the heavens about the planet. 20-feet reflector. The black division on the ring was as dark as the heavens. It was equally broad on both sides of the ring. With a 40-feet reflector, he saw the division on the ring of Saturn of the same colour as the surrounding heavens. It was of equal breadth on both sides, and he could trace it a great way towards the body of Saturn. With a 20-feet reflector, and power of 600, he could trace the division very nearly as far as the place, where a perpendicular to the direction of the ring would divide the open space between the planet and the ring into two equal parts.

From these observations, added to what has been given in some former papers, Dr. H. thinks himself authorised now to say, that the planet Saturn has two concentric rings, of unequal dimensions and breadth, situated in one plane, which is probably not much inclined to the equator of the planet. These rings are at a considerable distance from each other, the smallest being much less in diameter at the outside than the largest is at the inside. The dimension of the two rings and the intermediate space are nearly in the annexed proportion to each other.

	Parts.
Inside diameter of the smaller ring - -	5900
Outside diameter - - - - -	7510
Inside diameter of the larger ring - -	7740
Outside diameter - - - -	8300
Breadth of the inner ring - - -	805
Breadth of the outer ring - - -	280
Breadth of the vacant space - - -	115

Admitting, with M. de la Lande, that the breadth of the whole ring, as formerly supposed to consist of one entire mass, is near one third of the diameter of Saturn, it follows that the vacant space between the two rings, according to the above statement, amounts to near 2513 miles.

By way of forming more easily a comparative idea of the stupendous size of this ring of Saturn, Dr. H. calculated the proportion it bears to the earth, and found that its diameter is to that of the latter as 25.8914 to 1. From the above proportions we also compute that this ring must be upwards of 204,883 miles in diameter.

Experiments and Observations on the Production of Light from different Bodies, by Heat and by Attrition. By Mr. Thos. Wedgwood.

He found that the phosphorism of almost all bodies might be made apparent either by heat or by attrition; he therefore divides the subject of this paper into two parts. i. On the light produced by heat.—ii. On the light produced by attrition.

i. The best general method of producing the light by heat is, to reduce the body to a moderately fine powder, and to sprinkle it, by small portions at a time, on a thick plate of iron, or mass of burnt luting made of sand and clay, heated just below visible redness, and removed into a perfectly dark place. The following is a list of such bodies as he found to be luminous by this treatment, arranged according to the apparent intensity of their light.

1. Blue fluor, from Derbyshire, giving out a fetid smell on attrition.

2. Black and grey marbles, and fetid white marbles, from Derbyshire. Common blue fluor, from Derbyshire. Red feldspat, from Saxony.

3. Diamond. Oriental ruby. Aerated barytes, from Chorley, in Lancashire. Common whiting. Iceland spar. Sea shells. Moorstone, from Cornwall. White fluor, from Derbyshire.

4. Pure calcareous earth, precipitated from an acid solution. Pure argillaceous earth (of alum). Pure siliceous earth. Pure new earth, from Sydney Cove. Common magnesia. Vitriolated barytes, from Scotland. Steatites, from Cornwall. Alabaster. Porcelain clay of Cornwall. Mother of pearl. Black flint. Hard white marble. Rock crystal,

from the East Indies. White quartz. Porcelain. Common earthern ware. Whinstone. Emery. Coal ashes. Sea sand.

5. Gold, platina, silver, copper, iron, lead, tin, bismuth, cobalt, zinc. Precipitates by an alkali from acid solutions of gold, silver, copper, iron, zinc, bismuth, tin, lead, cobalt, mercury, antimony manganese. Vitriolated tartar, crystals of tartar, borax, alum, previously exsiccated. Sea-coal. White paper, white linen, white woollen, in small pieces, white hair powder. Deal saw-dust. Rotten wood (not otherwise luminous). White asbestos. Red irony mica. Deep red porcelain.

6. Antimony, nickel. Oils, lamp, linseed, and olive, white wax, spermaceti, butter, luminous at and below boiling.

The duration of the light thus produced from different bodies is very unequal; in some the light is almost momentary, in others it lasts for some minutes, and may be prolonged by stirring the powder on the heater. It soon attains its greatest brightness, and dies away gradually from that point, never appearing in a sudden flash, like the light of quartz-pebbles rubbed together. If blown on, it is suddenly extinguished, but immediately re-appears on discontinuing the blast.

The light of bodies is, in general, uncoloured; there, are however, some exceptions. Blue fluor, of that kind which gives out a fetid smell when rubbed, first emits a bright green light resembling that of the glow-worm so exactly, that when placed by the insect just as it has attained its greatest brightness, there is no sensible difference in the two lights, either of colour or intensity. This bright green quickly changes into a beautiful lilac, which gradually fades away. Fetid marbles, and some kinds of chalk, give a bright reddish or orange light; pure calcareous earth, a bluish white light; Cornish moorstone emits a fine blue light; powder of ruby gives a beautiful red light, of short continuance.

For the most part, the softest bodies require the least heat to become luminous: marble, chalk, fluor, &c. give a faint light when sprinkled on melted tin just becoming solid. As the temperature of the heater is raised, they continue to give out more and more light. Vitriols of iron, copper, and zinc, previously exsiccated, when thrown on earthern ware or metal made nearly red-hot, give minute flashes of light of momentary duration, such as appear from some of the metallic precipitates, particularly zinc, on a similar treatment; with this difference, however, that the light of most of the precipitates is of a reddish hue. The light of the metals is white, and exactly similar to that of some earths.

ii. The experiments on the light produced by different bodies by attrition were chiefly made by rubbing in the dark two pieces of the same kind against each other: all that were tried, with a very few exceptions, were luminous by this treatment. The following is a list of them, arranged in the order of the apparent intensity of their light, and as the lights are either white, or some shade of red, figures are affixed to denote these differences; (0) denoting a pure white light; (1), the faintest tinge of red, or flame colour; (2), a deeper shade of red; (3) and (4), still deeper shades.

1. Colourless, transparent, oriental rock-crystal; and siliceous crystals (0).
2. Diamond (0).
3. White quartz; white semi-transparent agate (1).
4. White agate, more opaque (2). Semi-transparent feldspat, from Scotland (2). Brown opaque feldspat, from Saxony (4). Chert of a dusky white, from North Wales (3).
5. Oriental ruby (4).
6. Topaz; oriental sapphire (0).
7. Agate, deep-coloured, brown and opaque (4).
8. Clear, blackish gun-flint (2).
9. Tawny semi-transparent flint (3).
10. Unglazed white biscuit earthen-ware (4).
11. Fine white porcelain (2).
12. Clear, blackish gun-flint, made opaque by heat (3).
13. Flint glass (0).
14. Plate glass; green-bottle glass (0).
15. Fine hard loaf-sugar (0).
16. Moorstone, from Cornwall (1). Corund, semi-transparent, from the East Indies (1).
17. Iceland spar (0).
18. White enamel (2); tobacco-pipe (3). White mica (0).
19. Unglazed biscuit earthen-ware, blackened by exposing it, buried in charcoal in a close crucible, to a white heat (4).
20. Black vitreous mass, made by melting together five of fluor, one of lime, and some charcoal powder (4).
21. Fluor; aerated and vitriolated barytes; white and black Derbyshire marble; calcareous spar; crystals of borax; deep blue grass; mother of pearl.

Rock-crystal, quartz, flint-glass, and many other hard bodies during attrition, emit now and then reddish sparks of a vivid light, which retain their brightness in a passage of one, two, and even three inches, through the air.

Bodies give out their light the instant they are rubbed on each other, and cease to be luminous when the attrition is discontinued. Colourless, transparent, and semi-transparent bodies emit a flashing light, their whole masses being, for a

moment, illuminated; opaque bodies give little more than a defined speck of red light, and are not luminous below the part struck. The greatest apparent quantity of light is produced by hard uncoloured, transparent, and semi-transparent bodies, whose surfaces soon acquire an asperity by rubbing together, as quartz, agate, &c.

From an examination of the table, it appears that white lights are emitted from colourless transparent bodies; faint red, or flame-coloured, from white semi-transparent bodies; deeper red from more opaque and coloured bodies, and the deepest red from opaque and from deep-coloured bodies. Extremely faint lights, such as those given by fluor, marble, &c. are of a bluish white; quartz, very lightly rubbed, gives a very faint light of a bluish hue; when rubbed a little harder, it emits a flame-coloured light; when rubbed with violence, its light approaches to whiteness. Opaque red feldspat gives a deep red light by attrition; exposed to a strong heat in the furnace, it becomes white, and somewhat transparent, and when cool, gives out, on attrition, as white a light as quartz; clear, blackish flint, made opaque by heat, gives a redder light than before; deep-coloured glass gives out a red defined light without any flash, while clear uncoloured glasses emit a white flashing light of some brightness.

Bodies are not luminous by simple pressure: but when they are at all broken by the pressure, the fragments rubbing on each other produce some light. Mr. Boyle, indeed, found a particular diamond to emit light when pressed by a steel bodkin; but the diamond is phosphorescent in so many ways, and is so curious and singular a body, both in properties and constitution, that it can scarcely be expected to exhibit the same appearances as the common class of earthy bodies.

All hard earthy bodies emit a peculiar smell on attrition. The most remarkable for this property are chert, quartz, feldspat, biscuit earthen-ware, and rock-crystal: this smell does not differ much in kind, though it does considerably in intensity. Many of the softer bodies yield the same smell, but in a less degree, and probably none are entirely without it. It appears to be strongest where the friction is greatest: it has no dependence on the light produced by attrition, as it is often very strong when no light is emitted. Rock-crystal, quartz, feldspat, white biscuit earthen-ware, and probably all such hard bodies, produce this smell under water. Quartz stones, violently rubbed on each other for a few minutes in a cup of water, communicate this smell, and a peculiar taste, to the

water. The taste is probably derived from an impalpable powder, which floats in the water for many days.

Derbyshire black marble, and the stinking blue fluor, give out, on attrition, a strong smell peculiar to themselves, both in air and water: they lose this property by being once made red-hot. Quartz produces the smell equally strong in fixed, pure, and common air.

Mr. W. having now stated all the facts relative to phosphorescent bodies which he had as yet been able to discover, offers a few reflections, tending to show, that heat is the probable cause of the light produced from bodies by attrition. It is easy to see why bodies emit light instantly when rubbed; for they often send out sparks as soon as the attrition commences, which proves that particles in their surfaces are instantly heated to redness by attrition. After all, it remains entirely problematical, in what manner heat operates to produce light from bodies: the air does not seem to have any concern in its production, as bodies are equally luminous in almost all kinds of air, and when immersed in liquids.

Observations on Bees. By JOHN HUNTER, *Esq. F.R.S.*

THE common bee, from a number of peculiarities in its economy, has called forth the attention of the curious; and from the profit arising from its labours it has become the object of the interested; therefore no wonder it has excited universal attention, even from the savage to the most civilised people.

When we talk of the economy of the colony, such as the secreting wax, making combs, collecting farina, honey, feeding the maggots, covering in the chrysalis, and the honey, stinging, &c. it is the labouring bees that are meant. As bees, from their numbers, hide very much their operations, it is necessary to have such contrivances as will explore their economy. Hives, with glass-lights in them, often show some of their operations, and when wholly of glass, still more; but as they form such a cluster, and begin their comb in the centre, little can be seen till their work becomes enlarged, and by that time they have produced a much larger quantity of bees, so as still to obscure their progress.

We find the common bee in Europe, Asia, Africa, and America. That they may be, or should be in the three first, is easily supposed, but how they came to America is not so readily conceived; for, though a kind of manageable animal, yet they do not like such long confinement in their hives as

would carry them to the West Indies, excepting in an ice-house; for when I have endeavoured to confine them in their hives, they have been so restless as to destroy themselves.

The female and the working bee, I believe, in every species have stings, which renders them an animal of offence, indeed, but rather of defence; for though they make an attack, I believe it is by way of defence, excepting when they attack each other, which is seldom or never with their stings. Of the whole bee-tribe, the common bee is the easiest irritated; for as they have property, they are jealous of it, and seem to defend it; but when not near it, they are quiet, and must be hurt before they will sting; with all this disposition for defence, which is only to secure their property, or themselves, when more closely attacked, yet they have no covetousness or a disposition to obstruct others. Thus, two bees or more will be sucking at the same flower, without the first possessor claiming it as his right: a hundred may be about the same drop of honey, if it is beyond the boundaries of their own right; but what they have collected they defend. It is easily known when they mean to sting: they fly about the object of their anger very quickly, and by the quickness of their motion evade being struck or attacked, which is discovered by the sound of their wings, as if going to give a stroke as they fly, a very different noise from that of the wings when coming home on a fine evening loaded with farina or honey; it is then a soft contented noise. When a single bee is attacked by several others, it seems the most passive animal possible, making no resistance, and even hardly seeming to wish to get away; and in this manner they allow themselves to be killed. They are, perhaps, the only insect that feeds in the winter, and therefore the only one that lays up external store.

Bees are, perhaps, the only insects that produce heat within themselves, and were therefore intended to have a tolerably well-regulated warmth, without which, of course, they are very uncomfortable, and soon die; and which makes not only a part of their internal economy respecting the individual, but a part of their external or common economy, and is therefore necessary to be known. The heat of bees is ascertainable by the thermometer; and I shall give the result of experiments made at two different seasons of the year. July 18th, at 10 in the evening, wind northerly, thermometer at 54°, in the open air, I introduced it into the top of a hive full of bees, and in less than five minutes it rose to 82°. I let it stand all night; at five in the morning it was down at 79°; at nine the

same morning it had risen to 83°, and at one o'clock to 84° and at nine in the evening it was down to 78°.

As they are easily affected by cold, their instinctive principle respecting cold is very strong, as also with regard to wet. I have seen a swarm hanging out at the door of a hive, ready to take flight, and then return; a chill has come on, of which I was not sensible, and in a few minutes the whole has gone back into the hive; and by the cold increasing, I have at length perceived the cause of their return. If rain is coming on, we observe them returning home in great numbers, and hardly any abroad. Bees are very cleanly animals respecting themselves; they seldom or never void their excrement in the hive. I have known them confined many days without discharging the contents of the rectum; and the moment they got abroad, they evacuated in the air when flying: and they appear to be very nice in their bodies; for I have often detected them cleaning each other, more especially if by accident they are besmeared with honey

To consider this society individually, it may be said to consist of a female breeder, female non-breeders, and males; but to consider it as a community, it may be said to consist only of female breeders and non-breeders, the males answering no other purpose than simply as a male, and are only temporary; and it is probable the female breeder is to be considered in no other light than as a layer of eggs, and that she only influences the non-breeders by her presence, being only a bond of union, for without her they seem to have no tie: it is her presence that makes them an aggregate animal. May we not suppose that the offspring of the queen have an attachment to the mother, somewhat similar to the attachment of young birds to the female that brings them up? for though the times of their attachment are not equal, yet it is the dependence which each has on its mother that constitutes the bond; for bees have none without her. When the queen is lost, this attachment is broken: they give up industry, probably die, or, we may suppose, join some other hive. This is not the case with those of this tribe whose queen singly forms a colony; for though the queen be destroyed, yet they go on with that work which is their lot; as the wasp, hornet, and humble bee. Most probably the whole economy of the bee, which we so much admire, belongs to the non-breeders, and depends on their instinctive powers being set to work by the presence of the breeders, that being their only enjoyment; therefore, when we talk of the wonderful economy of bees, it is chiefly the labourers at large we are to

admire, though the queen gets the principal credit, for the extent of their instinctive properties.

When a hive sends off a colony, it is commonly in the month of June; but that will vary according to the season, for in a mild spring bees sometimes swarm in the middle of May, and very often at the latter end of it. Before they come off, they commonly hang about the mouth of the hole, or door of the hive, for some days, as if they had not sufficient room within for such hot weather, which I believe is very much the case; for if cold or wet weather come on, they stow themselves very well, and wait for fine weather. But swarming appears to be rather an operation arising from necessity, for they would seem not naturally to swarm, because if they have an empty space to fill, they do not swarm; therefore by increasing the size of the hive, the swarming is prevented. This period is much longer in some than in others. For some evenings before they go forth is often heard a singular noise, a kind of ring, or sound of a small trumpet; by comparing it with the notes of the piano-forte, it seemed to be the same sound with the lower A of the treble.

The swarm commonly consists of three classes; a female, or females, males, and those commonly called mules, which are supposed to be of no sex, and are the labourers; the whole about two quarts in bulk, making about six or seven thousand. It is a question which cannot easily be determined, whether this old stock sends off entirely young of the same season, and whether the whole of their young ones, or only part. As the males are entirely bred in the same season part go off; but part must stay, and most probably it is so with the others. They commonly come off in the heat of the day, often immediately after a shower: who takes the lead I do not know, but should suppose it was the queen. When one goes off, they all immediately follow, and fly about seemingly in great confusion, though there is one principle actuating the whole.

They soon appear to be directed to some fixed place; such as the branch of a tree or bush, the cavities of old trees, holes of houses leading into some hollow place; and whenever the stand is made, they all immediately repair to it, till they are all collected. But it would seem, in some cases, that they had not fixed on any resting place before they came off, or if they had, that they were either disturbed, if it was near, or that it was at a great distance; for after hovering some time, as if undetermined, they fly away, mount up into the air, and go off with great velocity. When they have fixed on their

future habitation they immediately begin to make their combs, for they have the materials within themselves. I have reason to believe that they fill their crops with honey when they come away; probably from the stock in the hive.

A hive commonly sends off two, sometimes three, swarms in a summer; but the second is commonly less than the first, and the third less than the second; and this last has seldom time to provide for the winter: they often threaten to swarm, but do not; whether the threatening is owing to too many bees, and their not swarming is owing to there being no queen, I do not know It sometimes happens that the swarm goes back again; but in such instances I have reason to think that they have lost their queen, for the hives to which their swarm have come back do not swarm the next warm day, but will hang out for a fortnight, or more, and then swarm; and when they do, the swarm is commonly much larger than before, which makes me suspect that they waited for the queen that was to have gone off with the next swarm.

The materials of their dwelling, or, comb, which is the wax, is the next consideration, with the mode of forming, preparing, or disposing of it. The wax is formed by the bees themselves: it may be called an external secretion of oil; and I have found that it is formed between the scales of the under side of the belly. When I first observed this substance, in my examination of the working bee, I was at a loss to say what it was: I asked myself if it was new scales forming, and whether they cast the old, as the lobster, &c. does? but it was to be found only between the scales, on the lower side of the belly. On examining the bees through glass-hives, while they were climbing up the glass, I could see that most of them had this substance, for it looked as if the lower, or posterior edge of the scale, was double, or that there were double scales; but I perceived it was loose, not attached.

The cells, or rather the congeries of cells, which compose the comb, may be said to form perpendicular plates, or partitions, which extend from top to bottom of the cavity in which they build them, and from side to side. They always begin at the top, or roof of the vault, in which they build, and work downwards; but if the upper part of this vault, to which their combs are fixed, is removed, and a dome is put over, they begin at the upper edge of the old comb, and work up into the new cavity at the top. They generally may be guided, as to the direction of their new plates of comb, by forming ridges at top, to which they begin to attach their comb. In a long hive, if these ridges are longitudinal, their

plates of comb will be longitudinal; if placed transverse, so will be the plates; and if oblique, the plates of comb will be oblique. Each plate consists of a double set of cells, whose bottoms form the partition between each set. The plates themselves are not very regularly arranged, not forming a regular plane where they might have done so; but are often adapted to the situation, or shape of the cavity in which they are built. The bees do not endeavour to shape their cavity to their work, as the wasps do, nor are the cells of equal depths, also fitting them to their situation; but as the breeding cells must all be of a given depth, they reserve a sufficient number for breeding in, and they put the honey into the others, as also into the shallow ones. The attachment of the comb round the cavity is not continued, but interrupted, so as to form passages; there are also passages in the middle of the plates, especially if there be a cross stick to support the comb; these allow of bees to go across from plate to plate. The substance which they use for attaching their combs to surrounding parts is not the same as the common wax; it is softer and tougher, a good deal like the substance with which they cover in their chrysalis, or the humble bee surrounds her eggs. It is probably a mixture of wax with farina.

The cells are placed nearly horizontally, but not exactly so; the mouth raised a little, which probably may be to retain the honey the better: however, this rule is not strictly observed, for often they are horizontal, and towards the lower edge of a plane of comb they are often declining. The first combs that a hive forms are the smallest, and much neater than the last or lowermost. Their sides, or partitions between cell and cell, are much thinner, and the hexagon is much more perfect. The wax is purer, being probably little else but wax, and it is more brittle. The lower combs are considerably larger, and contain much more wax, or, perhaps more properly, more materials; and the cells are at such distances as to allow them to be of a round figure: the wax is softer, and there is something mixed with it.

There is a cell, which is called the royal cell, often three or four of them, sometimes more; I have seen 11, and even 13 in the same hive; commonly they are placed on the edge of one or more of the combs, but often on the side of a comb: however, not in the centre, along with the other cells, like a large one placed among the others, but often against the mouths of the cells, and projecting out beyond the common surface of the comb; but most of them are formed from the

edge of the comb, which terminates in one of these cells. The royal cell is much wider than the others, but seldom so deep: its mouth is round, and appears to be the largest half of an oval in depth, and is declining downwards, instead of being horizontal, or lateral. The materials of which it is composed are softer than common wax, rather like the last mentioned, or those of which the lower edge of the plate of comb is made, or with which the bees cover the chrysalis: they have very little wax in their composition, not one third, the rest I conceive to be farina.

I shall not consider the bee as an excellent mathematician, capable of making exact forms, and having reasoned on the best shape of the cell for capacity, so that the greatest number might be put into the smallest space; for the hornet and the wasp are much more correct, though not seemingly under the same necessity, as they collect nothing to occupy their cells; because, though the bee is pretty perfect in these respects, yet it is very incorrect in others, in the formation of the comb: nor shall I consider these animals as forming comb of certain shape and size from mere mechanical necessity, as from working round themselves · for such a mould would not form cells of different sizes, much less could wasps be guided by the same principle, as their cells are of very different sizes, and the first by much too small for the queen-wasp to have worked round herself: but I shall consider the whole as an instinctive principle, in which the animal has no power of variation, or choice, but such as arises from what may be called external necessity. The cell has in common six sides, but this is most correct in those first formed; and their bottom is commonly composed of those sides, or planes, two of the sides making one; and they generally fall in between the bottoms of three cells of the opposite side; but this is not regular, it is only to be found where there is no external interruption.

As soon as a few combs are formed, the female bee begins laying of eggs. As far as I have been able to observe, the queen is the only bee that propagates, though it is asserted that the labourers do. Her first eggs in the season are those which produce labourers; then the males, and probably the queen: this is the progress in the wasp, hornet, humble bee, &c.

It is not easy to fix the time when the eggs are hatched: I have been led to imagine it is in five days. When hatched, we find the young maggot lying coiled up in the bottom of the cell, in some degree surrounded with a transparent fluid.

In many of the cells, where the eggs are just hatched, we find the skin standing in its place, either not yet removed, or not pressed down by the maggot. There is now an additional employment for the labourers, namely, the feeding and nursing the young maggots. We may suppose the queen has nothing to do with this, as there are at all times labourers enough in the hive for such purposes, especially, too, as she never brings the materials, as every other of the tribe is obliged to do at first; therefore she seems to be a queen by hereditary, or rather, by natural right, while the humble bee, wasp, hornet, &c. seem rather to work themselves into royalty, or mistresses of the community. The bees are readily detected feeding the young maggot; and indeed a young maggot might easily be brought up by any person who would be attentive to feed it. They open their two lateral pincers to receive the food, and swallow it. As they grow, they cast their coats, or cuticles; but how often they throw their coats, while in the maggot state, I do not know. I observed that they often removed their eggs; I also find they very often shift the maggot into another cell, even when very large.

The maggots grow larger till they nearly fill the cell; and by this time they require no more food, and are ready to be inclosed for the chrysalis state: how this period is discovered I do not know, for in every other insect, as far as I am acquainted, it is an operation of the maggot, or caterpillar itself; but in the common bee, it is an operation of the perfect animal; probably it arises from the maggot refusing food. The time between their being hatched and their being inclosed is, I believe, four days; at least, from repeated observations, it comes nearly to that time: when ready for the chrysalis state, the bees cover over the mouth of the cell, with a substance of a light brown colour, much in the same manner that they cover the honey, excepting that, in the present instance, the covering is convex externally, and appears not to be entirely wax but a mixture of wax and farina. The maggot is now perfectly enclosed, and it begins to line the cell and covering of the mouth above mentioned, with a silk it spins out similar to the silk-worm, and which makes a kind of pod for the chrysalis. Bonnet observed, that in one instance the cell was too short for the chrysalis, and it broke its covering, and formed its pod higher, or more convex than common: this I can conceive possible; we often see it in the wasp. Having completed this lining, they cast off, or rather shove off, from the head backwards, the

last maggot coat, which is deposited at the bottom of the cell, and then they become chrysalises.

One would naturally suppose that the food of the maggot-bee should be honey, both because it is the food of the old ones, and it is what they appear principally to collect for themselves; however, the circumstance of honey being food for the old ones is no argument, because very few young animals live on the same food with the old, and therefore it is probable the maggot-bee does not live on honey; and if we reason from analogy, we shall be led to suppose the bee-bread to be the food of the maggot. It is the food of the maggot of the humble bee, who feeds on honey, and even lays up a store of honey for a wet day, yet does not feed the young with it. It is the food of the maggot of a black bee, and also of several others of the solitary kind, who also feed on honey; and wasps, &c. who do not bring in such materials, do not feed themselves on honey. We cannot suppose that the bee-bread is for the food of the old bees, when we see them collecting it in the months of June, July, &c. at which time they have honey in great plenty This substance is as common to a hive as any part belonging to the economy of bees. Before they have formed five or six square inches of comb in a young hive, we find eggs, honey, and bee-bread; and if a hive is short of honey, and dies in the winter, we find no honey, but all the bee-bread, which was laid up in store for the maggots in the spring. They take great care of it, for it is often covered over with wax, as the honey, and I believe more especially in the winter; probably with a view to preserve it till wanted.

This substance they bring in on their legs, and it consists of the farina of plants. It is not the farina of every plant that the bee collects, at least they are found gathering it from some with great industry, while we never find them on others: St. John's wort is a favourite plant, but that comes late. The flower of the gourd, cucumber, &c. they seem to be fond of. It is curious to see them deposit this substance in the cell. On viewing the hives, we often see bees with this substance on their legs, moving along on the combs, as if looking out for the cell to deposit it in. They will often walk over a cell that has some deposited in it, but leave that and try another, and so on till they fix; which made me conceive that each bee had its own cell. When they come to the intended cell, they put their two hind legs into it, while the two fore legs and the trunk out on the mouth of the neighbouring cell, and then the tail, or belly, is thrust down into

the intended cell; they then bring the leg under the belly, and turning the point of the tail to the outside of the leg, wherein the farina is, they shove it off by the point of the tail. When it is thus shoved off both legs, the bee leaves it, and the two pieces of farina may be seen lying at the bottom of the cell: another bee comes almost immediately, and creeping into the cell, continues about five minutes, kneading and working it down into the bottom, or spreads it over what was deposited there before, leaving it a smooth surface.

It is of a consistency like paste; burns slightly, and gives a kind of unusual smell, probably from having been mixed with animal juice in the act of kneading it down; for when brought in, it is rather a powder than a paste. That it is the food of the maggot is proved by examining the animal's stomach; for when we kill a maggot full grown, we find its stomach full of a similar substance, only softer, as if mixed with a fluid, but we never find honey in the stomach; therefore we are to suppose it is collected as food for the maggot, as much as honey is for the old bee.

In the chrysalis state they are forming themselves for a new life: they are either entirely new built, or wonderfully changed, for there is not the smallest vestige of the old form remaining; yet it must be the same materials, for now nothing is taken in. How far this change is only the old parts new modelled, or gradually altering their form, is not easily determined. To bring about the change, many parts must be removed, out of which the new ones are probably formed. When the chrysalis is formed into the complete bee, it then destroys the covering of its cell, and comes forth. The time it continues in this state is easier ascertained than either in that of the egg or the maggot; for the bees cannot move the chrysalis, as they do the two others. In one instance it was 13 days and 12 hours exactly; so that an egg in hatching being five days, the age of the maggot being four days, and the chrysalis continuing 13½, the whole makes 22½ days.

When the swarm is a large one, more especially if it was put into too small a hive, it often breeds too many for the hive to keep through the winter; and in such case a new swarm is thrown off, which, however, is commonly not a large one, and generally has too little time to complete its comb, and store it with honey sufficient to preserve them through the winter.

The new colony immediately sets about the increase of their numbers, and every thing relating to it. They have their apartments to build, both for the purpose of breeding, and as a storehouse for provisions for the winter. When the

season for laying eggs is over, then is the season for collecting honey; therefore, when the last chrysalis for the season comes forth, its cell is immediately filled with honey, and as soon as a cell is full, it is covered over with pure wax, and is to be considered as a store for the winter. This covering answers two very essential purposes: one is to keep it from spilling, or daubing the bees; the other to prevent its evaporation, by which means it is kept fluid in such a warmth. They are also employed in laying up a store of bee-bread for the young maggots in the spring, for they begin to bring forth much earlier than probably any other insect, because they retain a summer heat, and store up food for the young.

In the month of August, as the males do not provide for themselves, they become burdensome to the workers, and are therefore teased to death much sooner than they otherwise would die; and when the bees set about this business, of providing their winter-store, every operation is over, except the collecting of honey and bee-bread. At this time it would seem as if the males were conscious of their danger, for they do not rest on the mouth of the hive in either going out or coming in, but hurry either in or out: however, they are commonly attacked by one, two, or three at a time: they seem to make no resistance, only getting away as fast as possible. The labourers do not sting them, only pinch them, and pull them about as if to wear them out; but I suspect it may be called as much a natural as a violent death.

The queen, the mother of all, in whatever way produced, is a true female, and different from both the labourers and the male. She is not so large in the trunk as the male, and appears to be rather larger in every part than the labourers. The scales on the under surface of the belly of the labourers are not uniformly of the same colour, over the whole scale; that part being lighter which is overlapped by the terminating scale above, and the uncovered part being darker: this light part does not terminate in a straight line, but in two curves, making a peak; all which gives the belly a lighter colour in the labouring bees; more especially when it is pulled out or elongated. The tongue of the female is considerably shorter than that of the labouring bee, more like that of the male: however, the tongues of the labourers are not in all of an equal length, but none have it so short as the queen. The size of the belly of the female of such animals varies a little, according to the condition they are in: but the belly of the male and the labourer has but little occasion to change its size, as they are at all times nearly in the

same condition with regard to fat, having always plenty of provision: but the true female varies very considerably; she is of a different size and shape in the summer from what she is in the winter; and in the winter she has what may be called her natural size and shape; she is, on the whole, rather thicker than the labourer.

I believe a hive, or swarm, has but one queen, at least I have never found more than one in a swarm, or in an old hive in the winter; and, probably, this is what constitutes a hive; for when there are two queens, it is likely that a division may begin to take place.

The male bee is considerably larger than the labourers: he is even larger than the queen, though not so long when she is in her full state with eggs: he is considerably thicker than either, but not longer in the same proportion: he does not terminate at the anus in so sharp a point; and the opening between the last two scales of the back and belly is larger, and more under the belly, than in the female. His proboscis is much shorter than that of the labouring bee, which makes me suspect he does not collect his own honey, but takes that which is brought home by the others; especially as we never find the males abroad on flowers, &c. only flying about the hives in hot weather, as if taking an airing; and when we find that the male of the humble bee, which collects its own food, has as long a proboscis, or tongue, as the female, I think it is, from all these facts, reasonable to suppose, that the male of the common bee feeds at home. He has no sting.

The labouring bee is the largest in number of the whole community: there are thousands of them to one queen, and, probably, some hundreds to each male, as we shall see by and by. It is to be supposed they are the only bees which construct the whole hive, and that the queen has no other business but to lay the eggs: they are the only bees that bring in materials; the only ones we observe busy abroad; and, indeed, the idea of any other is ridiculous, when we consider the disproportion in numbers, as well as the employment of the others, while the working bee has nothing to take off its attention to the business of the family. They are smaller than either the queen or the males: not all of equal size, though the difference is not very great.

The number of labourers in a hive varies very considerably. In one hive there were 3338, in another 4472, in one that died there were 2432. That I might guess at the number of bees from a given bulk, I counted what number an ale-house

pint held, when wet, and found it contained 2160, therefore, as some swarms will fill two quarts, such must consist of near 9000.

Bees certainly have the five senses. Sight none can doubt. Feeling they also have; and there is every reason for supposing they have likewise taste, smell, and hearing. Taste we cannot doubt; but of smell we may not have such proofs: yet, from observation, I think they give strong signs of smell. Bees may be said to have a voice. They are certainly capable of forming several sounds. They give a sound when flying, which they can vary according to circumstances. One accustomed to bees can immediately tell when a bee makes an attack by the sound.

It is only the queen and the labourers that have stings; and this provision of a sting is, perhaps, as curious a circumstance as any attending the bee, and probably is one of the characters of the bee-tribe. The apparatus itself is of a very curious construction, fitted for inflicting a wound, and at the same time conveying a poison into that wound. The apparatus consists of two piercers, conducted in a groove or director, which appears to be itself the sting. This groove is somewhat thick at its base, but terminates in a point; it is articulated to the last scale of the upper side of the abdomen by 13 thin scales, six on each side, and one behind the rectum. These scales enclose, as it were, the rectum or anus all round: they can hardly be said to be articulated to each other, only attached by thin membranes, which allow of a variety of motions; three of them, however, are attached more closely to a round and curved process, which comes from the basis of the groove in which the sting lies, as also to the curved arms of the sting, which spread out externally.

The two stings may be said to begin by those two curved processes at their union with the scales, and converging towards the groove at its base, which they enter, then pass along it to its point. They are serrated on their outer edges, near to the point. These two stings can be thrust out beyond the groove, though not far, and they can be drawn within it; and, I believe, can be moved singly. All these parts are moved by muscles, which, we may suppose, are very strong in them, much stronger than in other animals; and these muscles give motion in almost all directions, but more particularly outwards. It is wonderful how deep they will pierce solid bodies with the sting. I have examined the length they have pierced the palm of the hand, which is

covered with a thick cuticle: it has often been about the one-twelfth of an inch.

The apparatus for the poison consists of two small ducts, which are the glands that secrete the poison: these two lie in the abdomen, among the air-cells, &c.: they both unite into one, which soon enters into, or forms, an oblong bag, like a bladder of urine; at the opposite end of which passes out a duct, which runs towards the angle where the two stings meet; and entering between the two stings is continued between them in a groove. which forms a canal by the union of the two stings to this point. There is another duct on the right of that described above, which is not so circumscribed, and contains a thicker matter, which, as far as I have been able to juge, enters along with the other: but it is the first that contains the poison, which is a thin clear fluid.

From the stings having serrated edges, it is seldom the bees can disengage them; and they immediately, on stinging, endeavour to make their escape, but are generally prevented, being, as it were, caught in their own trap; and the force they use commonly drags out the whole of the apparatus for stinging, and also part of the bowels; so that the bee most frequently falls a sacrifice immediately on having effected its purpose.

The life of the male is only one summer, or rather a month or two; and this we know from there being none in the winter, otherwise their age could not be ascertained, as it is impossible to learn the age of either the queen or labourers. But I think it is probable, also, that a certain number of young ones may be retained to keep up the stock, as we must suppose that many of the old ones are, from accidents of various kinds, lost to the hive; and we could conceive, that a hive three or four years old might not have an original bee in it, though a bee might live twice that time. But there must be a period for a bee to live; and, if I were to judge from analogy, I should say, that a bee's natural life is limited to a certain number of seasons.

Account of some remarkable Caves in the Principality of Bayreuth, and of the Fossil Bones found there. By John Hunter, *Esq.*

A ridge of primeval mountains runs almost through Germany: the highest parts of this ridge are granite, and are flanked by alluvial and stratified mountains, consisting chiefly of limestone marl, and sandstone; such at least is the tract

of hills in which the caves to be spoken of are situated, and over these hills the main road leads from Bayreuth to Erlang, or Nurenberg.

The tract of hills is there broken off by many small and narrow vallies, confined mostly by steep and high rocks, here and there overhanging, and threatening, as it were, to fall and crush all beneath; and every where thereabouts are to be met with objects which suggest the idea of their being evident vestiges of some general and mighty catastrophe, which happened in the primeval times of the globe. The strata of these hills consist chiefly of limestone of various colour and texture, or of marl and sandstones. The tract of limestone-hills abounds with petrifactions of various kinds.

The main entrance to the caves of Gailenreuth opens near the summit of a limestone-hill towards the east. An arch, near seven feet high, leads into a kind of ante-chamber, 80 feet in length and 300 feet in circumference, which constitutes the vestibule of four other caves.

In the passage to the third cave, some teeth and fragments of bones are found; but coming down to the pit of the cave, you are every where surrounded by a vast heap of animal remains. The bottom of this cave is paved with a stalactical crust of near a foot in thickness; large and small fragments of all sorts of bones are scattered every where on the surface of the ground, or are easily drawn out of the mouldering rubbish. The very walls seem filled with various and innumerable teeth and broken bones. The stalactical covering of the uneven sides of the cave does not reach quite down to its bottom, by which it plainly appears that this vast collection of animal rubbish some time ago filled a higher space in the cave, before the bulk of it sunk by mouldering.

This place is in appearance very like a large quarry of sandstones; and, indeed, the largest and finest blocks of osteolithical concretes might be hewn out in any number, if there was but room enough to come to them, and to carry them out. This bony rock has been dug into in different places, and every where undoubted proofs have been met with, that its bed, or this osteolithical stratum, extends every way far beneath and through the limestone-rock, into which and through which these caverns have been made, so that the queries suggesting themselves about the astonishing numbers of animals buried here confound all speculation. Along the sides of this cavern are some narrower openings, leading into different smaller chambers, of which it cannot be said how deep they go. In some of them, bones of smaller animals

have been found, such as jaw-bones, vertebræ, and tibiæ, in large heaps.

The bottom of this cave slopes toward a passage seven feet high, and about as wide, being the entrance to a

Fourth cave, 20 feet high and 15 wide, lined all round with a stalactical crust, and gradually sloping to another steep descent, where the ladder is wanted a second time, and must be used with caution as before, to get into a cave 40 feet high, and about half as wide. In those deep and spacious hollows, worked out through the most solid mass of rock, you again perceive, with astonishment, immense numbers of bony fragments of all kinds and sizes, sticking every where in the sides of the cave, or lying on the bottom.

Besides smaller hollows round this fourth cave, a very narrow opening has been discovered in one of its corners. It is of very difficult access, as it can be entered only in a crawling posture. This dismal and dangerous passage leads into a fifth cave, of near 30 feet high, 43 long, and of unequal breadth. To the depth of six feet this cave has been dug, and nothing has been found but fragments of bones, and animal mould: the sides are finely decorated with stalactites of different forms and colours; but even this stalactical crust is filled with fragments of bones sticking in it, up to the very roof. From this remarkable cave, another very low and narrow avenue leads into the last discovered, or the

Sixth cave, not very large, and merely covered with a stalactical crust, in which, however, here and there bones are seen sticking.

The bones sent by the Margrave of Anspach agree with those described and delineated by Esper as belonging to the white bear; how far they are of the same species among themselves, I cannot say: the heads differ in shape from each other: they are, on the whole, much longer for their breadth than in any carnivorous animal I know of; they also differ from the present white bear, which, as far as I have seen, has a common proportional breadth; it is supposed, indeed, that the heads of the present white bear differ from each other, but the truth of this assertion I have not seen heads enough of that animal to determine. The heads not only vary in shape, but also in size, for some of them, when compared with the recent white bear, would seem to have belonged to an animal twice its size, while some of the bones correspond in size with those of the white bear, and others are even smaller.

Bones of animals under circumstances so similar, though in

different parts of the globe, one would have naturally supposed to consist chiefly of those of one class or order in every place, one principle acting in all places. In Gibraltar they are mostly of the ruminating tribe, of the hare kind, and the bones of birds; yet there are some of a small dog or fox, and also shells. Those in Dalmatia appear to be mostly of the ruminating tribe, yet I saw a part of the os hyoides of a horse; but those from Germany are mostly carnivorous. From these facts we should be inclined to suppose, that their accumulation did not arise from any instinctive mode of living, as the same mode could not suit both carnivorous and herbivorous animals.

If the sea had not shifted its situation more than once, and was to leave the land in a very short time, then we could determine what the climate had formerly been by the extraneous fossils of the stationary animals, for those only would be found mixed with those of passage; but if the sea moves from one place to another slowly, then the remains of animals of different climates may be mixed, by those of one climate moving over those of another, dying, and being fossilised; but this I am afraid cannot be made out. By the fossils, we may, however, have some idea how the bones of the land animals fossilised may be disposed with respect to those of the sea.

If the sea should have occupied any space that never had been dry land prior to the sea's being there, the extraneous fossils can only be those of sea animals; but each part will have its particular kind of those that are stationary mixed with a few of the amphibia, and of sea birds, in those parts that were the skirts of the sea. I shall suppose that when the sea left this place it moved over land where both vegetables and land animals had existed, the bones of which will be fossilised, as also those of the sea animals; and if the sea continued long here, which there is reason to believe, then those mixed extraneous fossils will be covered with those of sea animals. Now if the sea should again move and abandon this situation, then we should find the land and sea fossils above mentioned disposed in this order; and as we begin to discover extraneous fossils in a contrary direction to their formation, we shall first find a stratum of those of animals peculiar to the sea, which were the last formed, and under it one of vegetables and land animals, which were there before they were covered by the sea; and among them those of the sea, and under this the common earth. Those peculiar to the sea will be in depth in

proportion to the time of the sea's residence, and other circumstances, as currents, tides, &c.

From a succession of such shiftings of the situation of the sea we may have a stratum of marine extraneous fossils, one of earth, mixed probably with vegetables and bones of land animals, a stratum of terrestrial extraneous fossils, then one of marine productions; but from the sea carrying its inhabitants along with it, wherever there are those of land animals there will also be a mixture of marine ones; and from the sea commonly remaining thousands of years in nearly the same situation, we have marine fossils unmixed with any others.

On the Nature and Construction of the Sun and fixed Stars. By WILLIAM HERSCHEL, *LL.D. F.R.S.*

AMONG the celestial bodies the sun is certainly the first which should attract our notice. It is a fountain of light that illuminates the world! it is the cause of that heat which maintains the productive power, and makes the earth a fit habitation for man! it is the central body of our planetary system; and what renders a knowledge of its nature still more interesting to us is, that the numberless stars which compose the universe, appear, by the strictest analogy, to be similar bodies. Their innate light is so intense, that it reaches the eye of the observer from the remotest regions of space, and forcibly claims his notice.

In the year 1779, there was on the sun a spot large enough to be seen with the naked eye. By a view of it with a seven-feet reflector, charged with a very high power, it appeared to be divided into two parts. The larger of them, on the 19th of April, measured 1′ 8″.06 in diameter; which is equal in length to more than 31,000 miles. Both together must certainly have extended above 50,000.

When we see a dark belt near the equator of the planet Jupiter, we do not recur to earthquakes and volcanoes for its origin. An atmosphere, with its natural changes, will explain such belts. Our spot in the sun may be accounted for on the same principles. The earth is surrounded by an atmosphere, composed of various elastic fluids. The sun also has its atmosphere, and if some of the fluids which enter into its composition should be of a shining brilliancy, in the manner that will be explained hereafter, while others are merely transparent, any temporary cause which may remove the lucid fluid will permit us to see the body of the sun through the trans-

parent ones. If an observer were placed on the moon, he would see the solid body of our earth only in those places where the transparent fluids of our atmosphere would permit him. In others, the opaque vapours would reflect the light of the sun, without permitting his view to penetrate to the surface of our globe.

I concluded, from appearances, that I viewed the real solid body of the sun itself, of which we rarely see more than its shining atmosphere. In the year 1783, I observed a fine large spot, and followed it up to the edge of the sun's limb. Here I took notice that the spot was plainly depressed below the surface of the sun; and that it had very broad shelving sides. I also suspected some part at least of the shelving sides to be elevated above the surface of the sun; and observed that, contrary to what usually happens, the margin of that side of the spot, which was farthest from the limb, was the broadest.

The luminous shelving sides of a spot may be explained by a gentle and gradual removal of the shining fluid, which permits us to see the globe of the sun. As to the uncommon appearance of the broadest margin being on that side of the spot which was farthest from the limb when the spot came near the edge of it, we may surmise that the sun has inequalities on its surface, which may possibly be the cause of it. For when mountainous countries are exposed, if it should chance that the highest parts of the landscape are situated so as to be near that side of the margin, or penumbra of the spot, which is towards the limb, it may partly intercept our view of it, when the spot is seen very obliquely.

The difference in the vanishing of the shelving side may, perhaps, be accounted from the real difference of the extent, the arrangement, the height, and the intensity of the shining fluid, added to the occasional changes that may happen in these particulars, during the time in which the spot approaches to the edge of the disk.

In the year 1791, I examined a large spot in the sun, and found it evidently depressed below the level of the surface; about the dark part was a broad margin, or plane of considerable extent, less bright than the sun, and also lower than its surface. This plane seemed to rise, with shelving sides, up to the place where it joined the level of the surface. In confirmation of these appearances, I carefully remarked that the disk of the sun was visibly convex.

Aug. 26. 1792, I examined the sun with several powers, from 90 to 500. It appeared evidently that the black spots

are the opaque ground, or body of the sun, and that the luminous part is an atmosphere, which, being interrupted or broken, gives us a transient glimpse of the sun itself. The seven-feet reflector, which was in high perfection, represented the spots, as it always used to do, much depressed below the surface of the luminous part. Sept. 2. 1792, I saw two spots in the sun with the naked eye. In the telescope I found they were clusters of spots, with many scattered ones besides. Every one of them was certainly below the surface of the luminous disk. The surface of the sun was unequal; many parts of it being elevated and others depressed. This is here to be understood of the shining surface only, as the real body of the sun can probably be seldom seen, otherwise than in its black spots.

Sept. 9. 1792, I found one of the dark spots in the sun drawn pretty near the preceding edge. In its neighbourhood I saw a great number of elevated bright places, making various figures: I shall call them faculæ, with Hevelius. I saw these faculæ extended, on the preceding side, over about one sixth part of the sun; but so far from resembling torches, they appeared like the shrivelled elevations on a dried apple, extended in length, and most of them joined together, making waves or waving lines. By some good views in the afternoon, I found that the rest of the surface of the sun does not contain any faculæ, except a few on the following and equatorial part of the sun. Towards the north and south I saw no faculæ: there was all over the sun a great unevenness in the surface, which had the appearance of a mixture of small points of an unequal light; but they are evidently an unevenness or roughness of high and low parts.

Sept. 11. 1792, the faculæ in the preceding part of the sun were much gone out of the disk, and those in the following come on. A dark spot also was come on with them. Sept. 13. 1792, there were a great number of faculæ on the equatorial part of the sun, towards the preceding and following parts. There were none towards the poles; but a roughness was visible every where. Sept. 16. 1792, the sun contained many large faculæ, on the following side of its equator, and also several on the preceding side; but none about the poles. They seemed generally to accompany the spots, and probably, as the faculæ certainly were elevations, a great number of them may occasion neighbouring depressions, that is, dark spots. The faculæ being elevations, very satisfactorily explains the reason why they disappear towards the middle of the sun, and re-appear on the other margin, for,

about the place where we lose them, they begin to be edgeways to our view; and if between the faculæ should lie dark spots, they will most frequently break out in the middle of the sun, because they are no longer covered by the side views of these faculæ.

Oct. 12. 1794, the whole surface of the sun was diversified by inequality in the elevation of the shining atmosphere. The lowest parts were every where darkest; and every little pit had the appearance of a more or less dark spot. A dark spot, on the preceding side, was surrounded by very great inequalities in the elevation of the lucid atmosphere; and its depression below the same was bounded by an immediate rising of very bright light. Oct. 13. 1794, the spot in the sun observed yesterday was drawn so near the margin, that the elevated side of the following part of it hid all the black ground, and still left the cavity visible, so that the depression of the black spots, and the elevation of the faculæ, were equally evident.

Nov. 26. 1794, eight spots in the sun, and several subdivisions of them, were all equally depressed. The sun was every where mottled. The mottled appearance of the sun was owing to an inequality in the level of the surface. The sun was equally mottled at its poles and at its equator; but the mottled appearances may be seen better about the middle of the disk than towards the circumference, on account of the sun's spherical form. The unevenness arising from the elevation and depression of the mottled appearance on the surface of the sun seemed, in many places, to amount to as much, or to nearly as much, as the depression of the penumbræ of the spots below the upper part of the shining substance, without including faculæ, which were protuberant. The lucid substance of the sun was neither a liquid nor an elastic fluid, as was evident from its not instantly filling up the cavities of the spots, and of the unevenness of the mottled parts. It exists, therefore, in the manner of lucid clouds swimming in the transparent atmosphere of the sun, or rather, of luminous decompositions taking place within that atmosphere.

That the sun has a very extensive atmosphere cannot be doubted; and that this atmosphere consists of various elastic fluids, that are more or less lucid and transparent, and of which the lucid one is that which furnishes us with light, seems also to be fully established by all the phenomena of its spots, of the faculæ, and of the lucid surface itself. There is no kind of variety in these appearances that may not be ac-

counted for with the greatest facility, from the continual agitation which we may easily conceive must take place in the regions of such extensive elastic fluids. It will be necessary, however, to be a little more particular, as to the manner in which I suppose the lucid fluid of the sun to be generated in its atmosphere. An analogy that may be drawn from the generation of clouds in our own atmosphere, seems to be a very proper one, and full of instruction.

According to the above theory, a dark spot in the sun is a place in its atmosphere which happens to be free from luminous decompositions; and that faculæ are, on the contrary, more copious mixtures of such fluids as decompose each other. The penumbra which attends the spots, being generally depressed, more or less, to about half way between the solid body of the sun and the upper part of those regions in which luminous decompositions take place, must, of course, be fainter than other parts. No spot favourable for taking measures having lately been on the sun, I can only judge, from former appearances, that the regions in which the luminous solar clouds are formed, adding also the elevation of the faculæ, cannot be less than 1843, nor much more than 2765 miles in depth.

The sun, viewed in this light, appears to be nothing else than a very eminent, large, and lucid planet, evidently the first, or, in strictness of speaking, the only primary one of our system, all others being truly secondary to it. Its similarity to the other globes of the solar system, with regard to its solidity, its atmosphere, and its diversified surface, and the rotation on its axis, leads us on to suppose, that it is, most probably, also inhabited, like the rest of the planets, by beings whose organs are adapted to the peculiar circumstances of that vast globe.

This way of considering the sun is of the utmost importance in its consequences. That stars are suns can hardly admit of a doubt. Their immense distance would perfectly exclude them from our view, if the light they send us were not of the solar kind. Besides, the analogy may be traced much further. The sun turns on its axis. So does the star Algol. So do the stars called Lyræ, Cephei, Antinoi, Ceti, and many more; most probably all. From what other cause can we so probably account for their periodical changes? Again, our sun has spots on its surface. So has the star Algol; and so have the stars already named; and probably every star in the heavens. On our sun these spots are changeable. So they are on the star Ceti; as evidently

appears from the irregularity of its changeable lustre, which is often broken in upon by accidental changes, while the general period continues unaltered. The same little deviations have been observed in other periodical stars, and ought to be ascribed to the same cause. But if stars are suns, and suns are inhabitable, we see at once what an extensive field for animation opens itself to our view.

In this place, I may, however, take notice that, from other considerations, the idea of suns or stars being merely the supporters of systems of planets, is not absolutely to be admitted as a general one. Among the great number of very compressed clusters of stars, given in my catalogues, there are some which open a different view of the heavens to us. The stars in them are so very close together, that notwithstanding the great distance at which we may suppose the cluster itself to be, it will hardly be possible to assign any sufficient mutual distance to the stars composing the cluster, to leave room for crowding in those planets, for whose support these stars have been, or might be, supposed to exist. It should seem, therefore, highly probable, that they exist for themselves, and are, in fact, only very capital, lucid, primary planets, connected together in one great system of mutual support.

As in this argument I do not proceed on conjectures, but have actual observations in view, I shall mention an instance in some of the clusters, of my catalogue of nebulæ. The stars in them are so crowded, that I cannot conjecture them to be at a greater apparent distance from each other than five seconds; even after a proper allowance for such stars, as on a supposition of a globular form of the cluster, will interfere with each other, has been made. Now if we would leave as much room between each of these stars as there is between the sun and Sirius, we must place these clusters 42,104 times as far from us as that star is from the sun. In some parts of the milky way, where yet the stars are not very small, they are so crowded, that in the year 1792, August 22., I found that in 41 minutes of time, no less than 258,000 of them had passed through the field of view of my telescope. It seems, therefore, on the whole, not improbable, that, in many cases, stars are united in such close systems as not to leave much room for the orbits of planets, or comets; and that, consequently, on this account also, many stars, unless we would make them mere useless brilliant points, may themselves be lucid planets, perhaps unattended by satellites.

An Account of the late Eruption of Mount Vesuvius. By Sir W. HAMILTON, *K.B. F.R.S. Dated Naples, August* 25. 1794.

ON Sunday the 15th of June, soon after 10 at night, a shock of an earthquake was felt at Naples; at the same moment a fountain of bright fire, attended with a very black smoke and a loud report, was seen to issue, and rise to a great height, from about the middle of the cone of Vesuvius; soon after another of the same kind broke out at some little distance lower down; then it had the appearance as if the lava had taken its course directly up the steep cone of the volcano. Fresh fountains succeeded each other hastily, and all in a direct line, tending, for about a mile and a half down, towards the towns of Resina and Torre del Greco. I could count 15 of them, but I believe there were others obscured by the smoke. It seems probable, that all these fountains of fire, from their being in such an exact line, proceeded from one and the same long fissure down the flank of the mountain, and that the lava and other volcanic matter forced its way out of the widest parts of the crack, and formed there the little mountains and craters hereafter described.

It is impossible that any description can give an idea of this fiery scene, or of the horrid noises that attended this great operation of nature. It was a mixture of the loudest thunder, with incessant reports, like those from a numerous heavy artillery, accompanied by a continued hollow murmur, like that of the roaring of the ocean during a violent storm; and added to these was another blowing noise, like that of the going up of a large flight of sky-rockets, and which brought to my mind also that noise which is produced by the action of the enormous bellows on the furnace of the Carron iron foundery in Scotland, and which it perfectly resembled. The frequent falling of the huge stones and scoriæ, which were thrown up to an incredible height from some of the new mouths, and one of which, having been since measured, was 10 feet high, and 35 in circumference, contributed, undoubtedly, to the concussion of the earth and air, which kept all the houses at Naples for several hours in a constant tremor, every door and window shaking and rattling incessantly, and the bells ringing.

All this time there was not the smallest appearance of fire or smoke from the crater on the *summit* of Vesuvius; but the black smoke and ashes issuing continually from so many new mouths, or craters, formed an enormous and dense body of

clouds over the whole mountain, and which began to give signs of being replete with the electric fluid, by exhibiting flashes of that sort of zig-zag lightning, which in the volcanic language of this country is called ferilli, and which is the constant attendant on the most violent eruptions. During 30 years that I have resided at Naples, and in which time I have been witness to many eruptions of Vesuvius, of different sorts, I never saw the gigantic cloud above mentioned replete with the electric fire, except in the two great eruptions of 1767, that of 1779, and during this more formidable one. The electric fire, in the year 1779, that played constantly within the enormous black cloud over the crater of Vesuvius, and seldom quitted it, was exactly similar to that which is produced, on a very small scale, by the conductor of an electrical machine communicating with an insulated plate of glass, thinly spread over with metallic filings, &c. when the electric matter continues to play over it in zig-zag lines without quitting it. I was not sensible of any noise attending that operation in 1779; whereas the discharge of the electrical matter from the volcanic clouds during this eruption, and particularly on the second and third days, caused explosions like those of the loudest thunder; and indeed the storms raised evidently by the sole power of the volcano resembled, in every respect, all other thunder-storms; the lightning falling and destroying every thing in its course.

The day on which Naples was in the greatest danger from the volcanic clouds, two small balls of fire, joined together by a small link like a chain-shot, fell close to my casino, at Pausilippo: they separated; and one fell in the vineyard above the house, and the other in the sea, so close to it that I heard a splash in the water. The Abbé Tata, in his printed account of this eruption, mentions an enormous ball of this kind which flew out of the crater of Vesuvius while he was standing on the edge of it, and which burst in the air at some distance from the mountain, soon after which he heard a noise like the fall of a number of stones, or of a heavy shower of hail.

About five o'clock in the morning of the 16th we could plainly perceive that the lava, which had first broke out from the several new mouths on the south side of the mountain, had reached the sea, and was running into it, having overwhelmed, burnt, and destroyed the greatest part of Torre del Greco, the principal stream of lava having taken its course through the very centre of the town. We observed, from Naples, that when the lava was in the vineyards in its way to

the town, there issued often, and in different parts of it, a bright pale flame, and very different from the deep red of the lava; this was occasioned by the burning of the trees that supported the vines. Soon after the beginning of this eruption, ashes fell thick at the foot of the mountain, all the way from Portici to the Torre del Greco; and though there were not at that time any clouds in the air, except those of smoke from the mountain, the ashes were wet, and accompanied with large drops of water, which, I was well assured, were to the taste very salt: the road, which is paved, was as wet as if there had been a heavy shower of rain. Those ashes were black and coarse, like the sand of the sea-shore, whereas those that fell there, and at Naples some days after, were of a light grey colour, and as fine as Spanish snuff, or powdered bark.

The breadth of the lava that ran into the sea, and has formed a new promontory there, after having destroyed the greatest part of the town of Torre del Greco, is 1204 English feet. Its height above the sea is 12 feet, and as many feet under water; so that its whole height is 24 feet: it extends into the sea 626 feet. I observed that the sea-water was boiling as in a cauldron, where it washed the foot of this new-formed promontory; and though I was at least 100 yards from it, observing that the sea smoked near my boat, I put my hand into the water, which was literally scalded; and by this time my boatmen observed that the pitch from the bottom of the boat was melting fast, and floating on the surface of the sea, and that the boat began to leak; we therefore retired hastily from this spot, and landed at some distance from the hot lava. The town of Torre del Greco contained about 18,000 inhabitants, all of which (except about 15, who from either age or infirmity could not be moved, and were overwhelmed by the lava in their houses,) escaped; but the rapid progress of the lava was such, that it ran like a torrent over the town of Torre del Greco, allowing the unfortunate inhabitants hardly time to save their lives: their goods and effects were totally abandoned; and indeed several of the inhabitants, whose houses had been surrounded with lava while they remained in them, escaped from them and saved their lives the following day, by coming out of the tops of their houses, and walking over the scoriæ on the surface of the red-hot lava.

The lava over the cathedral, and in other parts of the town, is upwards of 40 feet in thickness: the general height of the lava, during its whole course, is about 12 feet, and in some parts not less than a mile in breadth. I walked in the few

remaining streets of the town, and went on the top of one of the highest houses that was still standing, though surrounded by the lava: I saw from thence distinctly the whole course of the lava, that covered the best part of the town.

On Wednesday the 18th, the wind having for a very short time cleared away the thick cloud from the top of Vesuvius, we discovered that a great part of its crater, particularly on the west side opposite Naples, had fallen in, which it probably did about four o'clock in the morning of this day, as a violent shock of an earthquake was felt at that moment at Resina, and other parts situated at the foot of the volcano. The clouds of smoke were mixed with the fine ashes, which were of such a density as to appear to have the greatest difficulty in forcing their passage out of the now widely-extended mouth of Vesuvius, which certainly, since the top fell in, cannot be much short of two miles in circumference. One cloud heaped on another, and succeeding each other incessantly, formed in a few hours such a gigantic and elevated column of the darkest hue over the mountain, as seemed to threaten Naples with immediate destruction, having at one time been bent over the city, and appearing to be much too massive and ponderous to remain long suspended in the air; it was, besides, replete with the ferilli, or volcanic lightning, which was stronger than common lightning. The enormous mass of clouds certainly rose many miles above the mountain, which appeared like a mole-hill; though the perpendicular height of Vesuvius from the level of the sea is more than 3600 feet.

To avoid prolixity and repetition, I need only say, that the storms of thunder and lightning, attended at times with heavy falls of rain and ashes, causing the most destructive torrents of water and glutinous mud, mixed with huge stones, and trees torn up by the roots, continued more or less to afflict the inhabitants on both sides of the volcano till the 7th of July, when the last torrent destroyed many hundred acres of cultivated land, between the towns of Torre del Greco and Torre dell' Annunziata. Some of these torrents, both on the sea-side and the Somma side of the mountain, came down with a horrid rushing noise; and some of them, after having forced their way through the narrow gullies of the mountain, rose to the height of more than 20 feet, and were nearly half a mile in extent.

I went on Mount Vesuvius as soon as I thought I might do it with any degree of prudence, which was not till the 30th of June, and then it was attended with some risk. It was not possible to get up to the great crater of Vesuvius, nor had any

one yet attempted it. The horrid chasms that exist from the spot where the late eruption first took place, in a straight line for near two miles towards the sea, cannot be imagined. They formed vallies more than 200 feet deep, and from half a mile to a mile wide; and where the fountains of fiery matter existed during the eruption are little mountains with deep craters. Ten thousand men, in as many years, could not make such an alteration on the face of Vesuvius, as has been made by nature in the short space of five hours.

On the 19th, the ashes fell so thick at Somma, that unless a person kept in motion, he was soon fixed to the ground by them. This fall of ashes was accompanied also with loud reports, and frequent flashes of the volcanic lightning, so that, surrounded by so many horrors, it was impossible for the inhabitants to remain in the town, and they all fled: the darkness was such, though it was mid-day, that even with the help of torches it was scarcely possible to keep in the high road. I found that the majority of people were convinced that the torrents of mud and water, that had done them so much mischief, came out of the crater of Vesuvius, and that it was sea-water.

The darkness occasioned by the fall of the ashes in the Campagna Felice extended itself, and varied according to the prevailing winds. On the 19th of June it was so dark at Caserta, which is 15 miles from Naples, as to oblige the inhabitants to light candles at mid-day; and one day during the eruption the darkness spread over Beneventum, which is 30 miles from Vesuvius. The Archbishop of Taranto, in a letter to Naples, dated from Taranto the 18th of June, said, "We are involved in a thick cloud of minute volcanic ashes, and we imagine that there must be a great eruption either of Mount Etna or of Stromboli." The Bishop did not dream of their having proceeded from Vesuvius, which is about 250 miles from Taranto. We have had accounts also of the fall of the ashes during the late eruption at the very extremity of the province of Lecce, which is still farther off; and we have been also assured that those clouds were replete with electrical matter.

Upon the whole, having read every account of the former eruptions of Mount Vesuvius, I am well convinced that this eruption was by far the most violent that has been recorded after the two great eruptions of 79 and 1631, which were undoubtedly still more violent and destructive.

The very numerous population at the foot of Vesuvius is remarkable. From Naples to Castel-a-mare, about 15 miles,

the coast is so spread with houses as to be nearly one continued street, and on the Somma side of the volcano, the towns and villages are scarcely a mile from each other; so that for 30 miles, which is the extent of the basis of Mounts Vesuvius and Somma, the population may be perhaps more numerous than that of any other spot of a like extent in Europe, in spite of the variety of dangers attending such a situation.

On Hydatids. By Everard Home, *Esq.*

The animals called hydatids appear from their simplicity to be the furthest removed from the human; for as the human is the most complicated, and most perfect in the creation, the hydatid is one of the most simple, and composed of the fewest parts. It is to appearance *a membranous bag*, the coats of which are so thin as to be semi-transparent, and to have no visible muscular structure. From the effects produced by the different parts of this bag, while the animal is alive, being exactly similar to the contractions and relaxations of the muscular fibres in the human body, we must conclude that this membrane is possessed of a similar power, and, consequently, has the same right to be called muscular. The hydatid, from its apparent want of muscles, and other parts which generally constitute an animal, was for a long while denied its place in the animal world, and considered as the production of disease; we are however at present in possession of a sufficient number of facts, to ascertain, not only that it is an animal, but that it belongs to a genus of which there are several different species.

Hydatids are found to exist in the bodies of many quadrupeds, and often in the human: the particular parts most favourable to their support appear to be the liver, kidneys, and brain, though they are sometimes detected in other situations. One species is globular in its form, the outer surface of the bag smooth, uniform, and without any external opening: they are seldom found single, and are contained in a cyst, or thick membranous covering, in which they appear to lie quite loose, having no visible attachment to any part of it. This species is most frequently found in the liver and kidneys, both of the quadruped and human subject. They vary in size; but those most commonly met with are from one quarter of an inch to three quarters of an inch in diameter.

Another species is of an oval form, with a long process, or neck, continued from the smallest end of the oval, at the termination of which, by the assistance of magnifying glasses,

is to be seen a kind of mouth; but whether this is intended merely for the purpose of attachment, or to receive nourishment, is not easily determined. This species is found very commonly in the brain of sheep, and brings on a disease called by farmers the staggers. It is not peculiar to any one part of the brain, but is found in very different situations, sometimes in the anterior, at others in the posterior lobe. It is inclosed in a membranous cyst like the globular kind; but differs from that species in one only being contained in the same cyst; and the bag, or body of the animal, being less turgid, appearing to be about half filled with a fluid, in which is a small quantity of white sediment; while the globular ones are in general quite full and turgid. This species, from its containing only a small quantity of fluid, has a more extensive power of action on the bag, and is therefore best fitted for illustrating the muscular power of these animals.

If the hydatid be carefully removed from the brain, immediately after the sheep is killed, and put into warm water, it will soon begin to act with the different parts of the body, exhibiting alternate contractions and relaxations. These it performs to a considerable extent, producing a brisk undulation of the fluid contained in it: the action is often continued for above half an hour, before the animal dies; and is exactly similar to the action of muscles in the more perfect animals. This species of hydatid is very well known by the name tænia hydatigena: it varies considerably in its size. One of those which I examined alive was above five inches long, and nearly three inches broad at the broadest part, which makes it nine inches in the circumference. The coats of the hydatid, in their recent state, exhibit no appearance of fibres, even when viewed in the microscope; but when dried, and examined by glasses of a high magnifying power, they resemble paper made on a wire frame. This very minute structure is not met with in membranes in general; it may therefore be considered as the organisation on which their extensive motions depend. The coats of the different species of hydatids had all of them the same appearance in the microscope.

The intestines, in some of the more delicately-constructed animals, have a membranous appearance, similar to the bag of the hydatid; and we cannot doubt of their possessing a muscular power, since there is no other mode of accounting for the food being carried along the canal. The action of the intestines, not coming so immediately under our observation, makes them a less obvious illustration of this principle than the hydatid; we may however consider their having a similar

structure as a strong confirmation of it. If we compare the structure of muscles in the human body, with that of the membranous bag, a structure evidently endowed with a similar principle of action, the theories of muscular motion, which are founded on the anatomical structure of a complex muscle, must be overturned. The simplicity of form, in the muscular structure of this species of hydatid, makes it evident that the complex organisation of other muscles is not essential to their contraction and relaxation, but superadded for other purposes; which naturally leads us to suppose that this power of action, in living animal matter, is more simple, and more extensively diffused through the different parts of the body, than has been in general imagined.

On the Nature of the Diamond. By SMITHSON TENNANT, *Esq. F.R.S.*

As the nature of the diamond is so extremely singular, it seemed deserving of examination; and it will appear from the following experiments, that it consists entirely of charcoal, differing from the usual state of that substance only by its crystallised form. From the extreme hardness of the diamond, a stronger degree of heat is required to inflame it, when exposed merely to air, than can easily be applied in close vessels, except by means of a strong burning lens; but with nitre its combustion may be effected in a moderate heat.

To expose it to the action of heated nitre free from extraneous matters, I procured a tube of gold, which by having one end closed might serve the purpose of a retort, a glass tube being adapted to the open end for collecting the air produced. To be certain that the gold vessel was perfectly closed, and that it did not contain any unperceived impurities which could occasion the production of fixed air, some nitre was heated in it till it had become alkaline, and afterwards dissolved out by water; but the solution was perfectly free from fixed air, as it did not effect the transparency of lime-water. When the diamond was destroyed in the gold vessel by nitre, the substance which remained precipitated lime from lime-water, and with acids afforded nitrous and fixed air; and it appeared solely to consist of nitre partly decomposed, and of aerated alkali.

The quantity of fixed air produced by the diamond does not differ much from that which, according to M. Lavoisier, might be obtained from an equal weight of charcoal. In the Memoirs of the French Academy, he has related the various

experiments which he made to ascertain the proportion of charcoal and oxygen in fixed air. From those which he considered as most accurate, he concluded that 100 parts of fixed air contain nearly 28 parts of charcoal and 72 of oxygen. He estimates the weight of a cubic inch of fixed air under the pressure and in the temperature above mentioned, to be .695 parts of a grain. If we reduce the French weights and measures to English, and then compute how much fixed air, according to this proportion, $2\frac{1}{2}$ grains of charcoal would produce, we shall find that it ought to occupy very nearly the bulk of 10 ounces of water.

Experiments to determine the Force of fired Gunpowder. By Benj. Count Rumford, F.R.S. M.R.I.A

Mr. Robins, who made a great number of very curious experiments on gunpowder, concluded, as the result of all his enquiries and computations, that the force of the elastic fluid, generated in the combustion of gunpowder, is 1000 times greater than the mean pressure of the atmosphere. But Daniel Bernouilli determines its force to be not less than 10,000 times that pressure, or 10 times greater than Mr. Robins made it. In a paper printed in the year 1781, I gave an account of an experiment, by which it appeared that, calculating even on Mr. Robins's own principles, the force of gunpowder, instead of being 1000 times, must at least be 1308 times greater than the mean pressure of the atmosphere.

In order to make this experiment, I caused a new barrel to be constructed for that purpose: its length was 3.45 inches, and the diameter of its bore $\frac{7}{10}$ of an inch: its ends were closed up by two screws, each one inch in length, which were firmly and immovably fixed in their places by solder. The result of this experiment fully answered my expectations. The generated elastic fluid was so completely confined that no part of it could make its escape. The report of the explosion was so very feeble as hardly to be audible: indeed, it did not by any means deserve the name of a report, and certainly could not have been heard at the distance of 20 paces: it resembled the noise occasioned by the breaking of a very small glass tube. I imagined at first that the powder had not all taken fire, but the heat of the barrel soon convinced me that the explosion must have taken place; and after waiting near half a hour, on loosening the screw which closed the end of the long vent tube, the confined elastic vapours rushed

out with considerable force, and with a noise like that attending the discharge of an air-gun.

Having found means to confine the elastic vapour generated in the combustion of gunpowder, my next attempts were to measure its force. The principal objects I had in view were, first, to determine the expansive force of the elastic vapour generated in the combustion of gunpowder in its various states of condensation, and to ascertain the ratio of its elasticity to its density; and, secondly, to measure, by one decisive experiment, the utmost force of this fluid in its most dense state; that is to say, when the powder completely fills the space in which it is fired, and in which the generated fluid is confined. The dimensions of the barrel used in these experiments were as follow: Diameter of the bore at its muzzle = 0.25 of an inch. Joint capacities of the bore, and of its vent tube, exclusive of the space occupied by the leathern stopper, = 0.08974 of a cubic inch. Quantity of powder contained by the barrel and its vent tube when both were quite full, exclusive of the space occupied by the leathern stopper, 24½ grains Troy.

The elastic force of the fluid generated in the combustion of the charge of powder is measured by the weight by which it was confined, or rather by that which it was just able to move, but which it could not raise sufficiently to blow the leathern stopper quite out of the mouth of the bore of the barrel. This weight in all the experiments, except those which were made with very small charges of powder, was a piece of ordnance, of greater or less dimensions, or greater or less weight, according to the force of the charge; placed vertically on its cascabel, on the steel hemisphere which closed the end of the barrel; and the same piece of ordnance, by having its bore filled with a greater or smaller number of bullets, as the occasion required, was made to serve for several experiments.

It appears from 109 experiments, that in the afternoon of the 1st of July, 1793, the weight (which was a heavy brass cannon, a 24 pounder, weighing 8081 lbs. avoirdupois,) was not raised by 12 grains of powder, but that 13 grains raised it with an audible though weak report: that the next morning, July 2., at 10 o'clock, it was raised twice by charges of 12 grains: that in the morning of the 3d of July it was not raised by 12 grains, nor by 13 grains; but that 14 grains just raised it: that in the afternoon of the same day, two experiments were made with 14 grains of powder, in neither of which the weight was raised; but that in another experiment, in which 15 grains of powder were used, it was raised with a moderate report: that in the morning of the 8th of July, in two experiments, one with 15 grains, and the

other with 13 grains of powder, the weight was raised with a loud report; and in an experiment with 12 grains, it was raised with a feeble report: and, lastly, that in three successive experiments, made in the morning of the 17th of July, the weight was raised by charges of 12 grains. Hence it appears that under circumstances the most favourable to the developement of the force of gunpowder, a charge = 12 grains, filling $\frac{468}{1000}$ of the cavity in which it is confined, on being fired, exerts a force against the sides of the containing vessel equal to the pressure of 9431 atmospheres; which pressure amounts to 141,465 lbs. avoirdupois on each superficial inch.

I finish this paper by a computation, showing that the force of the elastic fluid generated in the combustion of gunpowder, enormous as it is, may be satisfactorily accounted for on the supposition that its force depends solely on the elasticity of watery vapour, or steam. It is certain that the heat generated in the combustion of gunpowder cannot possibly be less than that of red-hot iron. It is probably much greater, but we will suppose it to be only equal to 1000 degrees of Fahrenheit's scale, or something less than iron visibly red-hot in day-light. This is about as much hotter than boiling linseed oil, as boiling linseed oil is hotter than boiling water. As the elastic force of steam is just equal to the mean pressure of the atmosphere when its temperature is equal to that of boiling water, or to 212° of Fahrenheit's thermometer, and as its elasticity is doubled by every addition of temperature equal to 30 degrees of the same scale, with the heat of 242° its elasticity will be equal to the pressure of two atmospheres; at the temperature of 272° it will equal four atmospheres; and at two degrees above the heat of boiling linseed oil its elasticity will be equal to the pressure of 8192 atmospheres, or above eight times greater than the utmost force of the fluid generated in the combustion of gunpowder, according to Mr. Robins's computation. But the heat generated in the combustion of gunpowder is much greater than that of 602° of Fahrenheit's thermometer, consequently the elasticity of the steam generated from the water contained in the powder must of necessity be much greater than the pressure of 8192 atmospheres. Following up our computations on the principles assumed (and they are founded on the most incontrovertible experiments), we shall find that, at the temperature of 632°, the elasticity will be equal to the pressure of 16,384 atmospheres; at 662°, 32,768; at 692°, 65,536; and at 722°, the elasticity will be equal to the pressure of 131,072 atmospheres, which is 130 times greater than the elastic force

assigned by Mr. Robins to the fluid generated in the combustion of gunpowder; and about one sixth part greater than my experiments indicated it to be.

That the elasticity of steam would actually be increased by heat in the ratio here assumed, can hardly be doubted. It has absolutely been found to increase in this ratio in all the changes of temperature between the point of boiling water, I may even say of freezing water, and that of 280° of Fahrenheit's scale; and there does not appear to be any reason why the same law should not hold in higher temperatures.

A doubt might possibly arise with respect to the existence of a sufficient quantity of water in gunpowder, to fill the space in which the powder is fired, with steam, at the moment of the explosion; but this doubt may easily be removed. The best gunpowder, such as was used in my experiments, is composed of 70 parts in weight of nitre, 18 parts of sulphur, and 16 parts of charcoal; hence 1000 parts of this powder contain 673 parts of nitre, 173 parts of sulphur, and of charcoal 154 parts. Mr. Kirwan has shown that in 100 parts of nitre there are seven parts of water of crystallisation; consequently in 1000 parts of gunpowder, as it contains 673 parts of nitre, there must be 47 parts of water.

Charcoal exposed to the air has been found to absorb nearly one eight of its weight of water; and by experiments I have made on gunpowder, by ascertaining its loss of weight on being much dried, and its acquiring this lost weight again on being exposed to the air, I have reason to think that the power of the charcoal, which enters into the composition of gunpowder, to absorb water remains unimpaired, and that it actually retains as much water in that state as it would retain were it not mixed with the nitre and the sulphur.

1160 grains Troy of apparently dry gunpowder, taken from the middle of a cask, on being exposed 15 minutes in dry air, heated to the temperature of about 200°, was found to have lost 11 grains of its weight. This shows that each cubic inch of this gunpowder actually gave out $2\frac{1}{10}$ grains of water on being exposed to this heat; and there is no doubt but that at the end of the experiment it still retained much more water than it had parted with.

If now we compute the quantity of water which would be sufficient, when reduced to steam under the mean pressure of the atmosphere, to fill a space equal in capacity to one cubic inch, we shall find that either that contained in the nitre which enters into the composition of one cubic inch of gunpowder as water of crystallisation, or even that small quantity

which exists in the powder in the state of moisture, will be much more than sufficient for that purpose.

Hence we may venture to conclude, that the quantity of water actually existing in gunpowder is much more than sufficient to generate all the steam that would be necessary to account for the force displayed in the combustion of gunpowder, supposing that force to depend solely on the action of steam, even though no water should be generated in the combustion of the gunpowder. It is even very probable that there is more of it than is wanted, and that the force of gunpowder would be still greater, could the quantity of water it contains be diminished. From this computation it would appear, that the difficulty is not to account for the force actually exerted by fired gunpowder, but to explain the reason why it does not exert a much greater force.

An Enquiry concerning the Source of the Heat which is excited by Friction. By BENJAMIN, *Count* RUMFORD, *F.R.S.*

BEING engaged lately in superintending the boring of cannon in the workshops of the military arsenal at Munich, I was struck with the very considerable degree of heat which a brass gun acquires, in a short time, in being bored; and with the still more intense heat, much greater than that of boiling water, as I found by experiment, of the metallic chips separated from it by the borer. From whence comes the heat actually produced in the mechanical operation above mentioned? Is it furnished by the metallic chips which are separated by the borer from the solid mass of metal? If this were the case, then, according to the doctrine of latent heat, and of caloric, the capacity for heat of the parts of the metal, so reduced to chips, ought not only to be changed, but the change undergone by them should be sufficiently great to account for all the heat produced. But no such change had taken place.

Experiment 1. — This experiment was made in order to ascertain how much heat was actually generated by friction, when, a blunt steel borer being so forcibly shoved, by means of a strong screw, against the bottom of the bore of the cylinder, that the pressure against it was equal to the weight of about 10,000 lbs. avoirdupois, the cylinder was turned round on its axis, by the force of horses, at the rate of about 32 times in a minute. At the end of 30 minutes, when the cylinder had made 960 revolutions about its axis, the horses being stopped, a cylindrical mercurial thermometer, whose

bulb was $\frac{32}{100}$ of an inch in diameter, and $3\frac{1}{4}$ inches in length, was introduced into the hole made to receive it, in the side of the cylinder, when the mercury rose almost instantly to 130°.

Having taken away the borer, I now removed the metallic dust, or rather scaly matter which had been detached from the bottom of the cylinder by the blunt steel borer, in this experiment; and, having carefully weighed it, I found its weight to be 837 grains Troy. Is it possible that the very considerable quantity of heat that was produced in this experiment (a quantity which actually raised the temperature of above 113 lbs. of gun-metal at least 70° of Fahrenheit's thermometer, and which, of course, would have been capable of melting $6\frac{1}{2}$ lbs. of ice, or of causing near 5 lbs. of ice-cold water to boil,) could have been furnished by so inconsiderable a quantity of metallic dust? and this merely in consequence of a change of its capacity for heat?

Experiment 2. — The result of this beautiful experiment was very striking, and the pleasure it afforded me amply repaid me for all the trouble I had had, in contriving and arranging the complicated machinery used in making it. The cylinder, revolving at the rate of about 32 times in a minute, had been in motion but a short time, when I perceived, by putting my hand into the water, and touching the outside of the cylinder, that heat was generated; and it was not long before the water which surrounded the cylinder began to be sensibly warm. At the end of one hour, I found, by plunging a thermometer into the water in the box, (the quantity of which fluid amounted to 18.77 lbs. avoirdupois, or $2\frac{1}{4}$ wine gallons,) that its temperature had been raised no less than 47°; being now 107 of Fahrenheit's scale. When 30 minutes more had elapsed, or one hour and 30 minutes after the machinery had been put in motion, the heat of the water in the box was 142°. At the end of two hours, reckoning from the beginning of the experiment, the temperature of the water was found to be raised to 178°. At two hours 20 minutes it was at 200 ; and at two hours 30 minutes it actually boiled!

The quantity of heat produced equably, or in a continual stream, by the friction of the blunt steel borer against the bottom of the hollow metallic cylinder, in the experiment under consideration, was greater than that produced equably in the combustion of nine wax candles, each three-fourths of an inch in diameter, all burning together, or at the same time, with clear bright flames. As the machinery used in this experiment could easily be carried round by the force of

one horse, (though, to render the work lighter, two horses were actually employed in doing it) these computations show further how large a quantity of heat might be produced, by proper mechanical contrivance, merely by the strength of a horse, without either fire, light, combustion, or chemical decomposition; and, in a case of necessity, the heat thus produced might be used in cooking victuals.

By meditating on the results of all these experiments, we are naturally brought to that great question which has so often been the subject of speculation among philosophers; namely, what is heat? — Is there any such thing as an igneous fluid? — Is there any thing that can with propriety be called caloric? We have seen that a very considerable quantity of heat may be excited in the friction of two metallic surfaces, and given off in a constant stream or flux, in all directions, without interruption or intermission, and without any signs of diminution or exhaustion. Then whence came the heat which was continually given off in this manner, in the foregoing experiments? Was it furnished by the small particles of metal, detached from the larger solid masses, on their being rubbed together? This, as we have already seen, could not possibly have been the case. Was it furnished by the air? This could not have been the case; for in three of the experiments the machinery being kept immersed in water, the access of the air of the atmosphere was completely prevented.

And, in reasoning on this subject, we must not forget to consider that most remarkable circumstance, that the source of the heat generated by friction, in these experiments, appeared evidently to be inexhaustible. It is hardly necessary to add, that any thing which any insulated body, or system of bodies, can continue to furnish without limitation, cannot possibly be a material substance; and it appears to me to be extremely difficult, if not quite impossible, to form any distinct idea of any thing, capable of being excited, and communicated, in the manner the heat was excited and communicated in these experiments, except it be motion.

Singular Instance of atmospherical Refraction. By William Latham, *Esq. F.R.S. & A.S.*

July 26., about five o'clock in the afternoon, while sitting in my dining-room at this place (Hastings), which is situated on the Parade, close to the sea-shore, nearly fronting the south, my attention was excited by a great number of people running down to the sea-side.

On enquiring the reason, I was informed that the coast of France was plainly to be distinguished with the naked eye. I immediately went down to the shore, and was surprised to find that, even without the assistance of a telescope, I could very plainly see the cliffs on the opposite coast; which, at the nearest part, are between 40 and 50 miles distant, and are not to be discerned, from that low situation, by the aid of the best glasses. They appeared to be only a few miles off, and seemed to extend for some leagues along the coast.

I pursued my walk along the shore to the eastward, close to the water's edge, conversing with the sailors and fishermen on the subject. At first they could not be persuaded of the reality of the appearance; but they soon became so thoroughly convinced, by the cliffs gradually appearing more elevated, and approaching nearer, as it were, that they pointed out, and named to me, the different places they had been accustomed to visit; such as the Bay, the Old Head or Man, the Windmill, &c. at Boulogne; St. Vallery, and other places on the coast of Picardy; which they afterwards confirmed, when they viewed them through their telescopes. Their observations were, that the places appeared as near as if they were sailing, at a small distance, into the harbours.

Having indulged my curiosity on the shore for near an hour, during which the cliffs appeared to be at some times more bright and near, at others more faint and at a greater distance, but never out of sight, I went on the eastern cliff or hill, which is of a very considerable height, when a most beautiful scene presented itself to my view; for I could at once see Dungeness, Dover cliffs, and the French coast, all along from Calais, Boulogne, &c. to St. Vallery; and, as some of the fishermen affirmed, as far to the westward even as Dieppe.

By the telescope, the French fishing-boats were plainly to be seen at anchor; and the different colours of the land on the heights, with the buildings, were perfectly discernible. This curious phenomenon continued in the highest splendour till past eight o'clock, though a black cloud totally obscured the face of the sun for some time, when it gradually vanished. I was assured, from every enquiry I could make, that so remarkable an instance of atmospherical refraction had never been witnessed by the oldest inhabitant of Hastings, nor by any of the numerous visitors come to the great annual fair.

The day was extremely hot. I had no barometer with me, but suppose the mercury must have been high, as that and the three preceding days were remarkably fine and clear. To the best of my recollection, it was high water at Hastings

about two o'clock P. M. Not a breath of wind was stirring the whole of the day; but the small pennons at the mastheads of the fishing-boats in the harbour were in the morning at all points of the compass.

I was, a few days afterwards, at Winchelsea, and at several places along the coast, where I was informed the above phenomenon had been equally visible. When I was on the eastern hill, the cape of land called Dungeness, which extends nearly two miles into the sea, and is about 16 miles distant from Hastings, in a right line, appeared as if quite close to it as did the fishing-boats and other vessels, which were sailing between the two places; they were likewise magnified to a great degree.

The Croonian Lecture. Being Experiments and Observations on the Structure of Nerves. By Ev. Home, Esq. F.R.S.

The principal theories which have been formed respecting the structure of nerves, which have been taken notice of by Fontana, as they all differ from the observations which will be stated in the present paper, it may not be improper to mention the heads of each of them, so as to bring into one point of view all the knowledge that has been acquired on the subject. Torre found the medullary substance of the brain, spinal marrow, and nerves, to be a mass of transparent globules, swimming in a transparent fluid. When the parts were magnified 1000 times, the globules appeared largest in the brain, and smaller in the spinal marrow: they had no regular order; but in the nerves the globules were placed in lines, so as to give the appearance of fibres. In examining the optic nerve, the parts were magnified 120 times. Prochaska considered the nerves to be composed of globules, united by a transparent, elastic, cellular membrane, and disposed in straight lines, resembling fibres. Fontana found the primitive structure of nerves to consist of transparent cylinders, which, when united, formed the nerve: the manner of their being disposed is not mentioned. The objects were magnified 700 times, to show this appearance. Dr. Monro considered the nerves as made up of spiral fibres; but afterwards found that what he had described was entirely an optical deception. In his last work, he says, "The optic nerves have, in their whole course, less appearance of a fibrous structure than, perhaps, any other pair of nerves in the human body." Other authors may have written on this subject, and may have made observations on the structure of nerves, but want

of leisure must be an excuse for my not having come to a knowledge of them.

It is scarcely necessary to mention, that parts of an animal body are not fitted for being examined by glasses of a great magnifying power; and wherever they are shown 100 times larger than the natural size, no dependence can be placed on their appearance. In making the following microscopical experiments on the internal structure of the optic nerve, great care was taken to avoid the errors of former enquirers. The first experiments were made on transverse sections of the nerve. One, near its termination in the eye, was placed on glass, and exhibited in the microscope the following appearances: it was evidently composed of two parts, one opaque, the other transparent. The opaque portions were nearly circular in their shape, about 600 in number, and touched each other; the interstices between them were transparent. When the opaque parts were attentively examined in a favourable light, and the nerve was in a recent state, they were found to be made up of a great number of smaller portions, each of which appeared to be also opaque. To see this subdivision of parts required some attention, and in many sections it could not be perceived. The cause of the difficulty seemed to be, the softness and tenacity of the substance divided, which therefore spread itself over the surface, giving it a uniform appearance: but towards the circumference of the nerve, where the parts were cut obliquely, and some of them torn, the subdivision was very distinct.

Transverse sections were examined in different parts of the nerve, near the brain, towards the middle, and nearer the eye. In all the sections the nerve appeared to be made up of the same substances; but the size and number of the opaque parts differed very much. They have been stated, near the eye, to be 600; about the middle of the nerve, they were 150; and, near the brain, between the origin and union of the two nerves, they were only about 40. As they became larger, they were less regular in their shape, and had less of a circular form; nor were they uniform, some appearing very large, with one or two smaller placed between them.

After having succeeded in this examination of the nerve transversely, an attempt was made to investigate its structure in a longitudinal direction. To do this, a portion of the nervous pulp had its coat, formed by the dura mater, along with a thin vascular membrane which lines it, carefully removed for about an inch in length; the external surface of the pulp was then examined with a magnifying glass; the structure

was evidently fasciculated, but the fasciculi did not run parallel to each other; they seemed to unite together and separate again, in such a manner that any one of them could not be traced for half an inch in length, without being lost in the neighbouring part. When thin sections were examined in the field of the microscope, they put on the same appearance: this was equally the case, whether the part examined was near the centre or circumference of the nerve. The fasciculi were largest in that part of the nerve near the brain, and smallest towards the eye. Great pains were taken to ascertain whether the fasciculi were made up of continued fibres, or of small parts unconnected, which, from their position, gave that appearance; but every observation that was made was in proof of their being continued fibres.

From these experiments, the internal structure of the optic nerve appears to be made up in the following manner: At its origin from the brain it consists of 30 or 40 fasciculi, or bundles of extremely small opaque pulpy fibres, the interstices between which are filled with a transparent jelly. As the nerve goes farther from the brain, the fasciculi form smaller ones of different sizes. This is not done by a regular subdivision, but by a few fibres going off laterally from several large fasciculi, and being united, forming a smaller one: some of the fasciculi so formed, which are very small, unite again into one. In this way, the fasciculi gradually diminish in size, and increase in number, till they terminate in the retina. Near the eye, where the fasciculi are most numerous, the substance of the nerve has a considerable degree of transparency, from the number of transparent interstices between them; but this is less the case nearer the brain, where the interstices are fewer. In the optic nerve of the cat, the structure is the same as in the horse; but, from the smallness of the parts, less fitted for investigation. Near the eye, its internal substance is more transparent than the corresponding part in the horse.

To see how far this structure was peculiar to the optic nerve, similar experiments were made on the internal substance of the fifth and seventh pair of nerves, near their origin at the brain, and the structure was found to be the same. In these last-mentioned nerves, the interstices between the fasciculi were smaller than in the optic nerve, rendering their transverse sections less transparent; from which it is natural to suppose, that the internal parts of the optic nerve are not so compact as in other nerves, and therefore it is better fitted for examination.

These experiments show, that the nerves do not consist of tubes conveying a fluid, but of fibres of a peculiar kind, different from every thing else in the body, with which we are acquainted. The course of these fibres is very curious: they appear to be constantly passing from one fasciculus to another, so as to connect all the different fasciculi together by a mixture of fibres.

On a Submarine Forest, on the East Coast of England.

In the month of September, 1796, the narrator went to Sutton, on the coast of Lincolnshire, in company with Sir Joseph Banks, to examine their extent and nature.

He visited them again in the ebbs of the tide; and, though it generally did not ebb so far as he expected, he could, notwithstanding, ascertain, that they consisted almost entirely of roots, trunks, branches, and leaves of trees and shrubs, intermixed with some leaves of aquatic plants. The remains of some of these trees were still standing on their roots; while the trunks of the greater part lay scattered on the ground, in every possible direction. The bark of the trees and roots appeared generally as fresh as when they were growing; in that of the birches particularly, of which a great quantity was found, even the thin silvery membranes of the outer skin were discernible. The timber of all kinds, on the contrary, was decomposed and soft, in the greatest part of the trees; in some, however, it was firm, especially in the knots. The people of the country have often found among them very sound pieces of timber, fit to be employed for several economical purposes.

The sorts of wood which are still distinguishable are birch, fir, and oak. Other woods evidently exist in these islets, of some of which we found the leaves in the soil; but our present knowledge of the comparative anatomy of timbers is not so far advanced as to afford us the means of pronouncing with confidence respecting their species. In general, the trunks, branches, and roots of the decayed trees, were considerably flattened; which is a phenomenon observed in the Surtarbrand or fossil wood of Iceland, and which Scheuchzer remarked also in the fossil wood found near the lake of Thun, in Switzerland.

This moor extends over all the Lincolnshire fens, and has been traced as far as Peterborough, more than 60 miles to the south of Sutton. On the north side, the moory islets, according to the fishermen, extend as far as Grimsby, situated

on the south side of the mouth of the Humber, and it is a remarkable circumstance, that in the large tracts of low lands which lie on the south banks of that river, a little above its mouth, there is a subterraneous stratum of decayed trees and shrubs, exactly like those we observed at Sutton; particularly at Axholme isle, a tract of 10 miles in length, by five in breadth; and at Hatfield-chase, which comprehends 180,000 acres. Dugdale had long ago made this observation, in the first of these places, and De la Pryme in the second. The roots are there likewise standing in the places where they grew; the trunks lie prostrate. The woods are of the same species as at Sutton. Roots of aquatic plants and reeds are likewise mixed with them; and they are covered by a stratum of some yards of soil.

The fossil remains of vegetables hitherto dug up in so many parts of the globe, are, on a close inspection, found to belong to two very different states of our planet. The parts of vegetables, and their impressions, found in mountains of a cretaceous, schistous, or even sometimes of a calcareous nature, are chiefly of plants now existing between the tropics, which could neither have grown in the latitudes in which they are dug up, nor have been carried and deposited there by any of the acting forces under the present constitution of nature. The formation, indeed, of the very mountains in which they are buried. and the nature and disposition of the materials which compose them, are such as we cannot account for by any of the actions and re-actions which, in the actual state of things, take place on the surface of the earth.

The changes which these vegetables have suffered in their substance is almost total; they commonly retain only the external configuration of what they originally were. Such is the state in which they have been found in England, by Llwyd; in France, by Jussieu; in the Netherlands, by Burtin; not to mention instances in more distant countries. Some of the impressions or remains of plants found in soils of this nature, which were, by more ancient and less enlightened oryctologists, supposed to belong to plants actually growing in temperate and cold climates, seem, on accurate investigation, to have been parts of exotic vegetables. In fact, whether we suppose them to have grown near the spot where they are found, or to have been carried thither from different parts, by the force of an impelling flood, it is equally difficult to conceive, how organised beings, which, in order to live, require such a vast difference in temperature and in seasons, could live on the same spot, or how their remains

could, from climates, so widely distant, be brought together to the same place, by one common dislocating cause. To this ancient order of fossil vegetables belong whatever retains a vegetable shape, found in or near coal mines, and, to judge from the places where they have been found, the greater part of the agatised woods.

The second order of fossil vegetables comprehends those which are found in strata of clay or sand; materials which are the result of slow depositions of the sea or of rivers, agents still at work under the present constitution of our planet. These vegetable remains are found in such flat countries as may be considered to be of a new formation. To this last description of fossil vegetables the decayed trees here described certainly belong. They have not been transported by currents or rivers; but, though standing in their native soil, we cannot suppose the level in which they are found to be the same as that in which they grew. It would have been impossible for any of these trees and shrubs to vegetate so near the sea, and below the common level of its water: the waves would cover such tracts of land, and hinder any vegetation. We cannot conceive that the surface of the ocean has ever been lower than it now is; on the contrary, we are led by numberless phenomena to believe, that the level of the waters in our globe is much below what it was in former periods; we must, therefore, conclude, that the forest here described grew in a level high enough to permit its vegetation; and that the force, whatever it was, which destroyed it, lowered the level of the ground where it stood.

The shores of Alexandria, according to Dolomieu's observations, are a foot lower than they were in the time of the Ptolemies. Donati, in his natural history of the Adriatic, has remarked, seemingly with great accuracy, the effects of this subsidence at Venice; at Pola, in Istria; at Lissa, Bua, Zara, and Diclo, on the coast of Dalmatia. In England, Borlase has given a curious observation of a subsidence, of at least 16 feet, in the ground between Sampson and Trescaw islands, in Scilly. The soft and low ground between the towns of Thorne and Gowle, in Yorkshire, a space of many miles, has so much subsided in latter times, that some old men of Thorne affirmed, "that whereas they could before see little of the steeple of Gowle, they now see the churchyard wall." The instances of similar subsidence which might be mentioned are innumerable.

The stratum of soil, 16 feet thick, placed above the decayed trees, seems to remove the epoch of their sinking

and destruction far beyond the reach of any historical knowledge. In Cæsar's time, the level of the North Sea appears to have been the same as in our days. He mentions the separation of the Wahal branch of the Rhine, and its junction to the Meuse; noticing the then existing distance from that junction to the sea; which agrees, according to D'Anville's enquiries, with the actual distance. Some of the Roman roads constructed by order of Augustus, under Agrippa's administration, leading to the maritime towns of Belgium, still exist, and reach the present shore. It seems proved, from historical records, carefully collected by several learned members of the Brussels Academy, that no material change has happened to the lowermost part of maritime Flanders during the period of the last 2000 years.

Investigation of the Powers of the Prismatic Colours to heat and illuminate Objects. By WILLIAM HERSCHEL, *LL.D.*

Experiment 1.—Having arranged two thermometers in the place prepared for the experiment, I waited till they were stationary. Then, advancing No. 1. to the red rays, and leaving the other two close by, in the shade, I marked down what they showed at different times, as annexed. This, in about eight or ten minutes, gave 6¾ degrees, for the rising produced in my thermometer, by the red rays, compared to the standard thermometer.

No. 1	No. 2.
43¼	43½
48	43½
49½	43¼
49¾	43¼
50	43¼

Experiment 2.—Proceeding in the same manner as before, in the green rays I had as annexed. Therefore, in ten minutes, the green rays occasioned a rise of 3¼ degrees.

No 1.	No. 2.
43	43
45½	43
46	43
46	42¾
46	42¾

Experiment 3.—I now exposed my thermometer to the violet rays, and compared it with No. 2. Here we have a rising of 2°, in ten minutes, for the violet rays.

No. 1.	No. 2.
44	44
44	44
44¾	43½
45	43

From these experiments, we are authorised to draw the following results. In the red rays, my thermometer gave 6¾ degrees for the rising of the quicksilver. In the second experiment, we had 3¼ degrees, for the rising occasioned by the green rays; from which we obtain the proportion of 55 to 26, for the power of heating in red to that in green. The third experiment gave 2° for the violet rays; and

therefore we have the rising of the quicksilver in red to that in violet, as 55 to 16. Therefore, we have the proportion of the rising in red to that in green, as 27 to 11, or as 55 to 22.4.

Experiment on the illuminating Power of coloured Rays. — I placed an object that had very minute parts under a double microscope; and having set a prism in the window, so as to make the coloured image of the sun stationary on the table where the microscope was placed, I caused the differently coloured rays to fall successively on the object, by advancing the microscope into their light. The magnifying power was 27 times.

By an attentive and repeated inspection, I found that my object was very well seen in red; better in orange, and still better in yellow; full as well in green; but to less advantage in blue; indifferently well in indigo, and with more imperfection in violet.

From these and other observations we may conclude, that the red-making rays are very far from having it in any eminent degree. The orange possesses more of it than the red; and the yellow rays illuminate objects still more perfectly. The maximum of illumination lies in the brightest yellow, or palest green. The green itself is nearly equally bright with the yellow; but, from the full deep green, the illuminating power decreases very sensibly. That of the blue is nearly on a par with that of the red: the indigo has much less than the blue; and the violet is very deficient.

As an easy way of smoking glasses uniformly is of some consequence in astronomical observations, it may be of service here to give the proper directions, how to proceed in the operation.

With a pair of warm pliers, take hold of the glass, and place it over a candle, at a sufficient distance not to contract smoke. When it is heated, but no more than still to permit a finger to touch the edges of it, bring down the glass, at the side of the flame, as low as the wick will permit, which must not be touched. Then, with a quick vibratory motion, agitate it in the flame from side to side; at the same time advancing and retiring it gently all the while. By this method, you may proceed to lay on smoke to any required darkness. It ought to be viewed from time to time, not only to see whether it be sufficiently dark, but whether any inequality may be perceived; for if that should happen, it will not be proper to go on. The smoke of sealing-wax is bad: that of pitch is worse. A wax candle gives a good smoke; but that of a

tallow candle is better. As good as any I have hitherto met with, is the smoke of spermaceti oil. In using a lamp, you may also have the advantage of an even flame extended to any length.

Experiments on the Refrangibility of the invisible Rays of the Sun. By WM. HERSCHEL, *LL.D. F.R.S.*

MY experiments prove, that there are rays coming from the sun, which are less refrangible than any of those that affect the sight. They are invested with a high power of heating bodies, but with none of illuminating objects; and this explains the reason why they have hitherto escaped unnoticed. At the distance of ·52 inches from the prism, there was still a considerable heating power exerted by invisible rays, 1½ inch beyond the red ones, measured on their projection on a horizontal plane. I have no doubt but that their efficacy may be traced still somewhat farther. Experiments show, that the power of heating is extended to the utmost limits of the visible violet rays, but not beyond them; and that it is gradually impaired, as the rays get more refrangible. The maximum of the heating power is vested among the invisible rays; and is, probably, not less than half an inch beyond the last visible ones. The same experiments also show, that the sun's invisible rays, in their less refrangible state, and considerably beyond the maximum, still exert a heating power fully equal to that of red-coloured light; and that, consequently, if we may infer the quantity of the efficient from the effect produced, the invisible rays of the sun probably far exceed the visible ones in number.

If we call light, those rays which illuminate objects, and radiant heat, those which heat bodies, it may be enquired, whether light be essentially different from radiant heat? In answer to which I would suggest, that we are not allowed, by the rules of philosophising, to admit two different causes to explain certain effects, if they may be accounted for by one. A beam of radiant heat, emanating from the sun, consists of rays that are differently refrangible. The range of their extent, when dispersed by a prism, begins at violet-coloured light, where they are most refracted, and they have the least efficacy. We have traced these calorific rays throughout the whole extent of the prismatic spectrum; and found their power increasing, while their refrangibility was lessened, as far as to the confines of red-coloured light. But their diminishing refrangibility, and increasing power, did not stop here; for

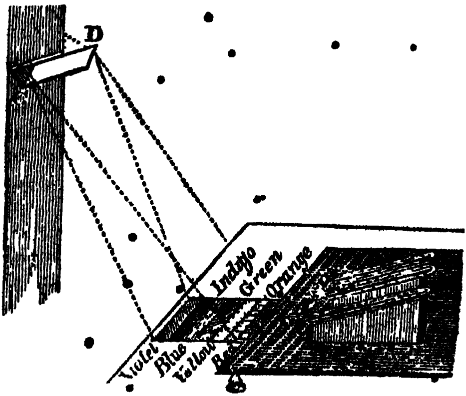
we have pursued them a considerable way beyond the prismatic spectrum, into an invisible state, still exerting their increasing energy, with a decrease of refrangibility up to the maximum of their power; and have also traced them to that state where, though still less refracted, their energy, on account, we may suppose, of their now failing density, decreased pretty fast; after which, the invisible thermometrical spectrum, if I may so call it, soon vanished.

The word heat, in its common acceptation, denotes a certain sensation well known to every person. I cannot be misunderstood as meaning that these rays themselves are heat; nor do I in any respect engage myself to show in what manner they produce heat.

From what has been said it follows, that any objections that may be alleged, from the supposed agency of heat in other circumstances than in its state of radiance, or heat-making rays, cannot be admitted against my experiments. For, notwithstanding I may be inclined to believe that all phenomena in which heat is concerned, such as the expansion of bodies, fluidity, congelation, fermentation, friction, &c. as well as heat in its various states of being latent, specific, absolute, or sensible, may be explained on the principle of heat-making rays, and vibrations occasioned by them in the parts of bodies; yet this is not intended, at present, to be any part of what I shall endeavour to establish. I must also remark, that in using the word rays, I do not mean to oppose, much less to countenance, the opinion of those philosophers who still believe that light itself comes to us from the sun, not by rays but by the supposed vibrations of an elastic ether, every where diffused throughout space; I only claim the same privilege for the rays that occasion heat, which they are willing to allow to those that illuminate objects. For, in what manner soever this radiance may be effected, it will be fully proved hereafter that the evidence, either for rays or for vibrations which occasion heat, stands on the same foundation on which the radiance of the illuminating principle, light, is built.

The similar propositions relating to heat, which are intended to be proved in this paper, will stand as follow: 1. Heat, both solar and terrestrial, is a sensation occasioned by rays emanating from candent substances, which have a power of heating bodies. 2. These rays are subject to the laws of reflection. 3. They are also subject to the laws of refraction. 4. They are of different refrangibility. 5. They are liable to be stopped, in certain proportions, when transmitted through

diaphanous bodies. 6. They are liable to be scattered on rough surfaces. 7. They may be supposed, when in a certain state of energy, to have a power of illuminating objects; but this remains to be examined.



In the view of the apparatus, 1, 2, 3, are the thermometers; the dotted lines are from the prism at the window; E the coloured spectrum thrown on the table, so as to bring the red colour near the bulbs of the thermometers.

Chemical Experiments on Zoophytes; with some Observations on the component Parts of Membrane. By CHARLES HATCHETT, *Esq. F.R.S.*

By the experiments, subsequently related, on various shells, crustaceous substances, and bones, it is proved, first, That the porcellaneous shells resemble the enamel of teeth in the mode of formation, but that the hardening substance is carbonate of lime.

2dly, That shells composed of nacre or mother of pearl, or approaching to the nature of that substance, and also pearls, resemble bone in a considerable degree, as they consist of a gelatinous, cartilaginous, or membranaceous substance, forming a series of gradations, from a tender and scarcely perceptible jelly to membranes completely organised, in and upon which carbonate of lime is secreted and deposited, after the manner that phosphate of lime is in the bones; and, therefore, as the porcellaneous shells resemble the enamel of teeth, so the shells formed of mother of pearl, &c. in like manner re-

semble bone; the distinguishing chemical character of the shells being carbonate of lime, and that of enamel and bones being phosphate of lime.

3dly, It is proved, that the crust which covers certain marine animals, such as crabs, lobsters, crayfish, and prawns, consists of a strong cartilage, hardened by a mixture of carbonate and phosphate of lime; and that thus these crustaceous bodies occupy a middle place between shell and bone, though they incline principally to the nature of shell.

And, 4thly, That a certain portion of carbonate of lime enters the composition of bones in general; the proportion of it, however, being to the phosphate of lime, vice versâ to that observed in the crustaceous marine substances. On the view, therefore, of these facts, it is evident, that there is a great similarity in the construction of shell and bone; and that there is even an approximation in the nature of their composition, by the intermediate crustaceous substances.

Many species of sponge were examined, but as little or no essential difference was found in the results, I shall include them all in what is now to be related. When digested with boiling distilled water, the sponges afforded a portion of animal jelly or gelatine, which was precipitated by infusion of oak bark. The fine and more flexible sponges yielded gelatine in greater abundance, and more easily, than those which were coarse and rigid. The gelatine was gradually and progressively imparted to the water, and seems, even in the same sponge, to be a constituent principle, of different degrees of solubility; and it must be noticed, that in proportion as the sponges, particularly those which were soft and flexible, were deprived of this substance, in the like proportion they became less flexible and more rigid. so that the remaining part, when dry, crumbled between the fingers; or, when moist, was torn easily, like wetted paper. As the above properties prove that sponges only differ from the horny stems of the gorgoniæ, and from the antipathes, by being of a finer and more closely woven texture, so this similarity will be corroborated by the following remarks: When exposed to heat, they yielded the same products, the same smell, and afforded a similar coal, which, by incineration, left a very small residuum, consisting chiefly of muriate of soda, occasionally mixed with some carbonate of lime, which was also often discovered when the recent sponges were immersed in acids; but this, as well as the muriate of soda, is, I believe, merely extraneous, and arises from small shells, parts of madrepores, and such like bodies, which are often visibly lodged in the interstices of the

sponges. Lastly, the sponges, when boiled with lixivium of caustic potash, were completely dissolved, and, like the horny stems of the gorgoniæ, formed animal soap, more especially when the part which is apparently insoluble in water, and which remains after the gelatine has been separated, was thus treated.

When the component parts of shell and bone are considered, it appears that the essential characteristics are, carbonate of lime for the one, and phosphate of lime for the other; and that their bases consist of the modifications of a glutinous, gelatinous, or membranaceous substance. I experienced much gratification in tracing the progressive and connected changes in the composition of the various shells and bones; and a considerable increase of pleasure arose, in proportion as the observations made on those bodies were corroborated, and the chain of connection extended, by the developement of the facts resulting from the experiments on zoophytes, which form the principal subject of this paper.

It will now be proper to review these experiments, and to examine how far they agree with those made on shell and bone, and how far they tend to prove, that these substances are all of a nature closely connected. The experiments on the madrepores afforded the following results: Madrepora virginea, when examined by acids, left but very little of any gelatinous substance or membrane. M. muricata, and M. labyrinthica, afforded loose portions of a transparent gelatinous substance. M. ramea, and M. fascicularis, when deprived of the carbonate of lime by acids, remained in the state of completely organised membranaceous bodies, which exhibited the original figure of the respective madrepores; and the proportion of coal afforded by these last was more abundant than what was obtained from those which were first mentioned.

To these succeeded the experiments on the millepores; from which it appeared, that millepora cærulea afforded loose detached portions of a gelatinous substance. M. alcicornis yielded the same, but in a more coherent state. M. polymorpha remained unchanged in shape, and consisted of a strong white opaque membrane, filled with a transparent jelly. Lastly, M. cellulosa, M. fascialis, and M. truncata afforded membranaceous bodies, in a complete state of organisation; and all these millepores, when exposed to a low red heat, yielded various quantities of coal, according to the greater or less abundance of the gelatinous or membranaceous substance.

The universal, and only hardening principle of these madrepores and millepores, was proved to be carbonate of lime, with the single exception of millepora polymorpha, which also appears to be differently constructed from the other milleporæ. With this single exception, carbonate of lime seems to be the only hardening substance in these bodies; and when every circumstance is considered, an exact similarity is to be found between the substance forming the various shells, and that which forms the madreporæ and milleporæ; and the nature of these bodies is so completely the same, that the changes or gradations of the one are to be found in the other. For the chemical characters which distinguish the porcellaneous shells are in a great measure approached by those of madrepora virginea; and those which were noticed in the patellæ correspond precisely with the madrepores and millepores, which afford a gelatinous substance; and, lastly, the characters of the membranaceous part, exhibited by the shells formed of nacre or mother of pearl, are, in like manner, to be found among some of the madrepores and millepores; such as madrepora ramea, millepora fascialis, millepora truncata; for these, like the turbo olearius and haliotis iris, are composed of a fibrous membrane, hardened by carbonate of lime. It appears, therefore, that the madrepores and millepores, like the various shells, are formed of a gelatinous or membranaceous substance, hardened by carbonate of lime; and the only difference is in the mode according to which these materials have been employed.

From what has been said, there is reason to conclude, that the varieties of bone, shell, coral, and the numerous tribe of zoophytes with which the last are connected, only differ in composition by the nature and quantity of the hardening or ossifying principle, and by the state of the substance with which it is mixed or connected. For the gluten or jelly which cements the particles of carbonate or phosphate of lime, and the membrane, cartilage, or horny substance, which serves as a basis, in and on which the ossifying matter is secreted and deposited, seem to be only modifications of the same substance, which progressively graduates from a viscid liquid or gluten, into that gelatinous substance which has so often been noticed, and which again, by increased inspissation, and by the various and more or less perfect degrees of organic arrangement, forms the varieties of membrane, cartilage, and horn.

I have had frequent occasion to remark, that a quantity of that animal jelly which is more or less soluble in water, and

which is distinguished by the name of gelatine, was obtained from many of the marine bodies, such as the sponges, the gorgoniæ, and others. As the quantities of gelatine are so various, so the properties of the substances in which it is present as a component part, are much influenced by it; and when, for example, the skins of different animals were compared, I have always found that the most flexible skins afforded gelatine more easily, and of a less viscid quality, than those which were less flexible, and of a more horny consistency. When hair of various qualities, and taken from different animals, was long digested or boiled with distilled water, it imparted to the water a small portion of gelatine, which was precipitated by the tanning principle, and by nitro-muriate of tin; and when the hair had been thus deprived of gelatine, and was subsequently dried in the air, the original flexibility and elasticity of it were found to be much diminished, so that it easily gave way, and was broken. This effect Mr. Achard has also noticed. Feather, digested in boiling distilled water, during 10 or 12 days, did not afford any appearance of gelatine by the test of the tanning principle; but nitro-muriate of tin produced a faint white cloud. The same was observed when quill was thus examined. Shavings and pieces of the horns of different animals were next subjected to experiment, and all afforded small quantities of gelatine.

Gelatine, according to its quantity and quality, has a powerful influence on some of the physical and chemical properties of the bodies in which it is present: by these properties, I mean flexibility, elasticity, and putrescibility. So much has been said already, in various parts of this paper, tending to prove how much the degrees of flexibility and elasticity, in various animal substances, depend on their gelatinous part, that little need be added; and when it is considered that bodies, such as muscular fibre, membrane, sponge, hair, and cuticle, being deprived of gelatine, and dried in the air, become rigid and brittle, no doubt can be entertained but that this arises from the loss of the gelatinous substance; and, as an additional proof, when bodies, such as nail, feather, quill, and tortoise-shell, which contain little or no gelatine, are long boiled, and then dried in the air, like the former, they are found to have suffered scarcely any alteration in their respective degrees of flexibility and elasticity. As to putrefaction, it is obvious to every one, that certain parts of animals are much more susceptible of it than others; and that when the carcass of an animal begins to putrefy, the

most humid and flexible parts are always first affected. Thus, the viscera, muscles, and cutis, soon suffer a change; while hair, feather, scale, horn, hoof, and nail, remain unchanged, ages after the former have decomposed; and this is evidently caused by the gelatine and moisture, which are combined in the former, and not in the latter, at least in any notable quantity.

Gelatine, albumen, and muscular fibre, not only differ very much from each other by the relative quantity of their saline or earthy residua, but also by the proportion of one of their essential and elementary principles, namely, carbon. 500 grains of isinglass, made perfectly dry by distillation, yielded 56 grains of coal, from which, 1.50 grains of earthy residuum, obtained by incineration, being deducted, the proportion of coal appears to have been 54.50 grains. 500 grains of dry albumen afforded 74.50 grains; and as the saline residuum amounted to 11.25 grains, the quantity of mere coal was 63.25 grains 500 grains of tortoise-shell yielded 80 grains of coal; from which three grains of earthy matter being deducted, 77 grains remain for the proportion of coal. And 500 grains of the dry prepared muscular fibre of beef, when distilled, left 108 grains of coal, which, by incineration, afforded 25.60 grains of earthy residuum; the coal may therefore be estimated at 82.40 grains. There appears much reason, therefore, to believe that the gelatinous substances and muscular fibre, differ from simple and unorganised albumen, by a diminution of the carbonic principle in the one, and by an excess of it in the other; and as, in vegetables, the fibrous part is that which contains the largest proportion of carbon, so in respect to the other animal substances, muscular fibre appears to contain the greatest quantity of it.

As the three principal and essential component parts of the blood, viz. albumen, gelatine, and fibre, appear therefore to compose the various parts of animals, in such a manner that one, being predominant, influences the nature of that part of the animal which it is principally employed to form; and as albumen, gelatine, and fibre, by relative proportion, by the degrees of density, by the effects of organisation, which, singly or conjointly they have experienced, by the texture of the animal substance which they, as materials, and thus modified, have concurred to produce, and by the proportion of natural or inherent moisture, peculiar to each part of different animals, present an immense series of complicated causes; so are the effects found to be no less numerous and diversified, by the infinite variety in texture, flexibility, elasticity, and the many

other properties, peculiar to the various parts which compose the bodies of animals.

The whole of the blood, which by anatomists is divided into serum, red globules, and coagulating lymph, when chemically examined, is found to consist of albumen, gelatine, and fibre. The serum which remains liquid after the coagulation of the blood, is composed of albumen, gelatine, some saline matter, and much water. The clot, or crassamentum, also affords, by repeated washing, a large proportion of albumen and gelatine; after which a substance remains, in appearance very analogous to muscular fibre, excepting that is in a more attenuated state. This substance, called fibrin by chemists, may be regarded as that part of the blood which has undergone the most complete animalisation; and from which the muscular fibre and other organs of the body are formed.

Experiments on the Ascent of the Sap in Trees. By Mr. Knight.

Early in the spring of 1799, he selected a number of young trees of different kinds, and made circular incisions round one-half of them, scraping off the external coat of the wood, the other half being left in their natural state. On the ascent of the sap they all shot with equal luxuriance, but that part of the stems which was *below* the incisions had scarcely any growth, while the parts *above* increased as rapidly as in the trees the bark of which had remained untouched.

From these experiments, varied in every way that occurred to him, Mr. Knight feels himself justified in concluding, that the current of sap, which adds to the annual layer of wood in the stem, *descends* through the bark, from the young branches and leaves.

Observations by Dr. Herschel, with a view of investigating the Nature of the Sun, &c.

It appears that this body has a planetary atmosphere, which extends to a great height, and is of great density: that, like ours, it is subject to agitations, and is transparent. This astronomer thinks that solar observations may hereafter be rendered as profitable to mankind as the Nilometer is to the Egyptians, and that, by certain indications, we may be able to predict the temperature of approaching seasons. He supposes it probable that there may be a certain connection between the price of corn, or rather the abundance and scan-

tiness of harvest, and the number of spots on the sun's surface.

In proof of this he has given a statement of the prices of wheat, and the spots on the sun's disk, during five remarkable periods between 1650 and 1713. He considers the sun's spots to be symptoms of a copious emission of light and heat; and that in proportion as their number is greater or less, may be expected more or less abundant crops of corn.

In a second paper on the same subject, Dr. Herschel proposes thermometrical observations, as a future criterion of a defective or copious emission of the solar rays. He suspects that one half of the sun is less favourable to a copious emission of rays than the other; and that its variable lustre may possibly appear, to other solar systems, as irregular periodical stars are seen by us.

Experiments on the Light which is spontaneously emitted from various Bodies, and on Solar Light. By Dr. Hulme.

It appears, from the first series, that objects, as fish, which abound with spontaneous light in a latent state, do not emit it, when deprived of life, but from such parts as have been some time in contact with the air, and that a blast from bellows does not increase this species of light, as it does that which proceeds from combustion.

From a second series it appears, that oxygen gas does not act upon this light, so as to render it more vivid than it is in atmospherical air.

From the third series, it is deserving of remark, that azotic gas is favourable to the spontaneous light emitted from fishes, but extinguishes that proceeding from rotten wood.

From the fourth and fifth it appears, that hydrogen and carbonic acid gases prevent the emission of spontaneous light, and extinguish it when emitted.

The next three series of experiments show, that sulphurated hydrogen gas extinguishes spontaneous light sooner than carbonic acid gas; that nitrous gas prevents the emission of light, and extinguishes that which is emitted, and that it is completely extinguished in a vacuum.

Fro[illegible]e other experiments it appears, that solar light, when [illegible]ed by Canton's phosphorus, is subject to the same [illegible] with respect to heat and cold, as the spontaneous lig[illegible]fishes, rotten wood, and glow-worms.

On the Theory of Light and Colours. By Dr. Young.

The three essential hypotheses noticed by Dr. Young, and considered by him literally as parts of the more complicated Newtonian system, are,

1. That a luminiferous ether pervades the universe, rare and elastic in a high degree.

2. That undulations are excited in this ether whenever a body becomes luminous; and,

3. That the sensation of different colours depends on the different frequency of vibrations excited by light in the retina.

The fourth hypothesis, viz. That all material bodies have an attraction for the ethereal medium, by means of which it is accumulated within their substance, and for a small distance around them, in a state of greater density, but not of greater elasticity, is diametrically opposite to that of Newton, but considered by Dr. Young as the most simple and best capable of explaining the phenomena.

Experiments and Observations on certain Stony Substances, which at different Times are said to have fallen on the Earth. By Luke Howard, Esq.

We have here historical accounts of all those facts on the subject which seem to be well authenticated. Particular mention is made of one that fell in Portugal in 1796; of about a dozen that fell at Sienna in July, 1794; of one that weighed 56 lbs. that fell in December, 1795, near Wold-cottage, in Yorkshire: and of others that fell in 1798, near Benares, in the East Indies

We have then a mineralogical description of these various stones, by the Count de Bournon; after which, Mr Howard proceeds to consider the assistance to be derived from the science of chemistry, in distinguishing them from all other known substances, and in establishing the assertion that they have fallen on the earth.

Count de Bournon's description of native iron, and Mr. Howard's examination of specimens of iron from South America, Bohemia, and Senegal, follow in succession; from which the author, instead of drawing any conclusions, proposes the following queries: —

1. Have not all *fallen* stones, and what are called native irons, the same origin?

2. Are all or any, the produce, or the bodies of meteors?

3. Might not the stone from Yorkshire have formed a meteor in regions too elevated to be discovered?

On the Construction of the Heavens. By Dr. Herschel.

Dr. H. has taken a very enlarged view of the sidereal bodies of the universe; and has enumerated a great diversity of parts that enter into the construction of the heavens. The first species are insulated stars, such as the author considers our sun, and all the brightest stars, which he supposes are nearly out of the reach of mutual gravitations; for, stating the annual parallax of Sirius at 1", he calculates that Sirius and the sun, if left alone, would be 33,000,000 of years in falling together, and that the action of the stars in the milky way, as well as others, would tend to protract this time much more.

He conjectures that insulated stars alone are surrounded with planets. With respect to double stars, he thinks that they preserve their relative distances by a periodical revolution round a common centre. The same theory he applies to triple, quadruple, and multiple systems of stars; and pursues his conjectures still farther to clusters and groups of stars, as well as to the nebulæ, some of which he thinks may be so distant, as for the rays of light to take 2,000,000 of years in travelling from them to our system.

Account of some cases of the production of Colours not hitherto described. By Dr. Young.

His method of accounting for atmospherical haloes is as follows: When a number of fibres of the same kind, for instance a uniform lock of wool, is held near the eye, we see an appearance of haloes surrounding a distant candle; but their brilliancy, and even their existence, depends on the uniformity of the dimensions of the fibres, and they are larger as the fibres are smaller. It is obvious that they are the immediate consequences of the coincidence of a number of fringes of the same size; which, as the fibres are arranged in all imaginable directions, must necessarily surround the luminous object at equal distances on all sides, and constitute circular fringes.

There can be little doubt that the coloured atmospherical haloes are of the same kind; their appearance must depend on the existence of a number of particles of water, of equal dimensions, and in a proper position with respect to the luminary and the eye. As there is no natural limit to the magnitude

of the spherules of water, we may expect these haloes to vary without limit in their diameters; and it has been observed not only that their dimensions are various, but that they frequently change during the time of observation.

A Catalogue of 500 new Nebulæ, Nebulous Stars, Planetary Nebulæ, and Clusters of Stars, with Remarks on the Construction of the Heavens. By Dr. HERSCHEL.

IN dividing the different parts of which the sidereal heavens are composed in proper classes, Dr. Herschel is obliged to examine the nature of the various celestial objects that have been hitherto discovered, in order to arrange them in a manner most conformable to their construction. He first treats of *insulated stars*. It might be expected that the solar system would stand foremost in the list, whereas, by treating of insulated stars, we seem, as it were, to overlook one of the great component parts of the universe. It will, however, appear that this very system, magnificent as it is, can only rank as a single individual belonging to the species which we are going to consider.

By calling a star insulated, Dr. Herschel does not mean to denote its being totally unconnected with all other stars or systems; but when stars are situated at such immense distances from each other as our Sun, Arcturus, Capella, Lyra, Sirius, and numberless others, we think that we may look upon them as sufficiently out of the reach of mutual attractions, to deserve the name of insulated stars. For it is ascertained by computation that, supposing the earth's orbit, as is highly probable, does not subtend more than an angle of one second of a degree, when seen from Sirius, then the Sun and Sirius, if the masses are equal, would not fall together in less than thirty-three millions of years, even though they were not impeded by many contrary attractions of other neighbouring insulated stars. A star thus situated may certainly deserve to be called insulated, and of this kind our Sun is probably one.

From the detached situation of insulated stars, it appears that they are capable of being centres of extensive planetary systems; and from analogy we may suppose, that every one of them is attended with planets, satellites, and numerous comets; though there is good reason for believing that we can only look for solar systems among insulated stars.

The next part of the construction of the heavens, is the union of two stars, that are formed together into one system,

by the laws of attraction: these he denominates *binary sidereal systems, or double stars.* If a star be situated at any distance behind another, and but little deviating from the line in which the first is seen, there would be the appearance of a double star, but they would not form a binary system. If, however, two stars should be really situated near each other, and at the same time so far insulated as not to be materially affected by the attractions of neighbouring stars, they will then compose a separate system, and remain united by the bond of their mutual gravitation towards each other. This should be called a real double star; and any two stars that are thus mutually connected, form a binary sidereal system.

Dr. Herschel then proceeds to *triple, quadruple, quintuple, and multiple stars,* and shows, first, that three stars may be preserved in a permanent connection, by revolving in proper orbits about a common centre of motion. Having demonstrated the fact, he says, if we admit of triple stars, we can have no reason to oppose more complicated connections.

In answering the objection which may be made, that possibly all this sort of reasoning may be useless and fanciful, he says, such combinations as I have mentioned are not the inventions of fancy: they have an actual existence, and I could point them out by thousands. There is not a single night, when, in passing over the zones of the heavens, by sweeping, I do not meet with numerous collections of double, triple, quadruple, quintuple, and multiple stars, apparently insulated from other groups, and probably joined in some small sidereal system of their own.

In treating of *clustering stars,* and the *milky way,* Dr. Herschel says, that the stars of which the milky way is composed are very unequally scattered, and show evident marks of clustering together into many separate allotments. Thus in the space between β and γ Cygni, the stars are seen clustering together towards two different regions; and, taking the average breadth in this space about five degrees, it contains more than 331,000 stars, and, admitting them to be clustering two different ways, there will be 165,000 for each clustering collection; this name the milky appearances certainly deserve, as they are brighter about the middle, and fainter near their undefined borders; and that the brightness of the milky way arises only from stars, is evident, since their compression increases in proportion to the brightness of the milky way.

From clustering stars there is but a short transition to *groups of stars,* which is Dr. Herschel's 5th division. A group is a collection of closely, and almost equally, com-

pressed stars, of any figure or outline, sufficiently separated from neighbouring stars to show that it makes a peculiar system of its own.

Of *clusters of stars*, which are most magnificent objects to be seen in the heavens: — their form is generally round, and the compression of the stars shows a gradual and pretty sudden accumulation towards a centre, the existence of which cannot be doubted, either in a state of real solidity, or in that of an empty space, possessed of an hypothetical force, arising from the joint exertion of the numerous stars that enter into the composition of the cluster.

Nebulæ, which, on account of their great distances, can only be seen by instruments of great space-penetrating power. These Dr. Herschel thinks may all be resolved into the three last mentioned species, which, at certain immense distances, will put on the appearance of nebulæ. Nebulæ are objects that may be perceived at the greatest distance, but only with a telescope of great power, which, says the astronomer, has not only a power of penetrating into space, but a power also of penetrating into time past. To explain this, we are reminded, that when we look upon Sirius, the rays that enter the eye cannot have been less than six years and four months and a half coming from that star to the observer. Hence it follows, that when we see an object of the calculated distance at which one of these remote nebulæ may be perceived, the rays of light which convey its image to the eye must have been more than 1,910,000 years on their way; and that consequently so many years ago this object must already have had an existence in the sidereal heavens, in order to send out those rays by which we now perceive it.

Of stars with burs — These may be a real cluster of stars, the whole light of which is gathered so nearly into one point, as to leave but just enough of the light of the cluster visible to produce the appearance of burs.

The phenomenon of *milky nebulosity* is probably of two kinds; one of them deceptive, namely, such as arises from widely-extended regions of closely-connected clustering stars, contiguous to each other, like the collections that construct our milky way; the other being real, and possibly at no very great distance from us; but of its nature Dr. Herschel does not presume to speak.

The nature of *nebulous stars* is enveloped in much obscurity, and will probably, according to our astronomer, require ages of observations before we can form a proper estimate of their

condition. There is no doubt of the starry nature of the central point; but the great distance of such stars renders the real extent of the surrounding nebulosity a surprising phenomenon, which, in other circumstances, might be imputed to an atmosphere.

Experiments and Observations on the various Alloys, on the specific Gravity and on the comparative Wear of Gold. By Mr. Hatchett.

The first series of experiments was intended to examine the effects which various metals produce upon gold, when combined with it in given proportions, beginning with one twelfth, which is the standard proportion of alloy, and gradually decreasing to $\frac{1}{1920}$ part of the mass. The results drawn from these experiments were, that fine gold alloyed with silver, with copper, and with tin, did not suffer any loss during the experiment. That gold alloyed with lead only, lost three grains, chiefly by vitrification; with iron it lost 12 grains, which formed scoria; with bismuth it lost also 12 grains, chiefly by vitrification; with antimony it lost the same quantity, partly by volatilisation, and partly by vitrification; with zinc it lost a penny-weight by volatilisation; and with arsenic it not only lost the whole quantity of alloy, but also two grains of the gold which were carried off in consequence of the rapid volatilisation of the arsenic.

Hence it is likewise inferred, that only two of the metals are proper for the alloy of gold coin, namely, silver and copper; as all the others either considerably alter the colour or diminish the ductility of gold.

It is well known that the specific gravity of an alloyed metal is seldom that, which, by calculating the specific gravities and proportions of the different metals, would be the result; but it is greater or less than it ought to be according to calculation.

It appears that the specific gravity of gold alloyed with different metals, is not only very different to what it ought to be, according to calculations made on the relative proportions and specific gravity of the alloy, but that it is also subject to many variations, partly occasioned by peculiar effects, produced by certain proportions of some of the metals, and partly by effects peculiar to certain compound alloys; so that, by the proportions of certain metals, and by the combination of these with others, an immense complicated series of alterations in specific gravity are produced, which have not been

investigated by those philosophers who have written on the specific gravity of metals.

As general results of each part of this enquiry, it may be observed, that the experiments on the various alloys of standard gold concur with established practice and opinion to prove, that only two of the metals, viz. silver and copper, are proper to be employed in the reduction of fine gold to standard, for the purpose of coin: that numerous causes influence the specific gravity of metals; in some cases metals added to others produce a contraction in the bulk of the mass, or an increase of specific gravity, but in others the effects produced are exactly the reverse: that gold of moderate ductility is the best adapted to the purpose of coin, and that the real wear of such coin is very slowly effected; so that a long period of time must elapse before any considerable diminution in weight can be perceived.

Observations on the Structure of the Tongue. By Mr. Everard Home.

A gentleman, by accident, had his tongue bitten with great violence, which occasioned great local pain, and the point of it lost its sensibility, and was deprived of the power of taste. It was like a piece of board in his mouth, which rendered the act of eating a very unpleasant operation. From this case, Mr. Home concludes, that the tongue itself is not particularly irritable; but the nerves passing through the substance to supply the tip, which forms the organs of taste, are very readily deprived of their natural action, which, probably, arises from their being softer in texture than nerves in general, and, in that respect, resembling those belonging to the other organs of sense.

Another curious circumstance is, that a bruise upon the nerves of the tongue, sufficient to deprive them of the power of communicating sensation, was productive of no inflammation or irritation in the nervous trunk; from which it is inferred, that the nerves supplying an organ of sense are not so liable to such effects as those which belong to the other parts of the body. Hence, in several cases of tumours of the size of a pea, Mr. Home has successfully taken away that portion of the tongue upon which they grew, by means of a needle armed with a double ligature.

From these cases Mr. Home concludes, that the tongue is less irritable than almost any other organised part of the body; therefore the peculiar substance which is interposed

between the fasciculi of its muscular fibres, is not in any respect connected with the nerves which pass through its substance to the organ of taste, but is merely a soft medium, to admit of great facility of action in its different parts.

Account of the Measurement of an Arc of the Meridian, extending from Dunmose, in the Isle of Wight, latitude 50° 37′ 8″ *to Clifton, in Yorkshire, latitude* 53° 27′ 31″ *carried on in the Years* 1800, 1801, *and* 1802. *By Mr.* MUDGE.

DUNMOSE being fixed on, his object was to carry on the triangles as nearly as possible in the direction of its meridian, selecting the stations, so that their sides might be properly inclined to it, and of sufficient length. The northern station was to be brought as near the meridian of the southern one as possible, and likewise in the neighbourhood of some open spot of ground, proper for the measurement of a base of verification. A station having these advantages was found near Clifton, a small village in the vicinity of Doncaster, and a level of sufficient extent for a base, on Misterton Carr, in the northern part of Lincolnshire. At Clifton the direction of the meridian was obtained from numerous observations on the polar star, at the times of its greatest eastern and western elongations from the meridian.

From this measurement it appears, that the length of a degree on the meridian in latitude 52° 2′ 20″ is 60,820 fathoms, supposing the whole arc subtending an angle of 2° 50′ 23″.38, in the heavens, and a distance of 1,036,337 feet on the surface of the earth.

The length of the degree at the middle point (51° 35′ 18″) between the southern extremity of the arc and Arbury Hill, is 60,864 fathoms, which exceeds the above by 44 fathoms. But this degree, admitting the earth to be an ellipsoid, with the ratio of its axes as 229 to 230, should be about 10 fathoms less.

From the late operations of the French academicians, it appears that the meridional distance between Dunkirk and Barcelona is 3,527,921 feet; the distance between Dunkirk and Paris is 133,758 feet; and the distance between Paris and Greenwich is 963,954 feet; therefore the distance between Greenwich and Dunkirk is 830,196 feet. The distance between Greenwich and Clifton is 722,641 feet; hence 4,411,968 feet is the meridional distance between Clifton and Barcelona. We thus find the mean length of a degree on the earth's surface, in latitude 47° 21′, to be 60,795 fathoms. The

meridional distance is 1,686,595 feet, and 60,825 fathoms is the length of the degree in latitude 51° 9.

Experiments on Trees. By Mr. Knight.

The sap, having been absorbed by the bark of the root, is carried up by the alburnum, or white wood, of the root, the trunk, and the branches; it passes through what are there called the central vessels, into the succulent part of the annual shoot, the leaf stalk, and the leaf; and it returns to the bark through the returning vessels of the leaf-stalk.

Mr. Knight begins with the leaf, from which, he assumes, all the descending fluids in the tree are derived. The efforts which plants always make to turn the upper surfaces of their leaves to the light, have induced naturalists to conclude, that each surface has a totally distinct office. Mr. Knight has detailed a number of experiments to support that conclusion. From these he infers, that in the vine, the perspiratory vessels are confined to the *under* surface of the leaf, and that they, like the cutaneous lymphatics of the animal economy, are probably capable of absorbing moisture when the plant is in a state to require it. The *upper* surface seems, from the position it assumes, either formed to absorb light, or to operate by the influence of that body; and if any thing exhale from it, it is probably vital air, or some other permanently elastic fluid. It is known, that perpendicular shoots grow with greater vigour than others, and Mr. Knight imputes it, from some experiments, to a more minute and rapid circulation.

To prove the effects of motion on the circulation of the sap, he selected a number of young seedling apple-trees, whose stems were about an inch in diameter. By means of stakes and bandages of hay, not so tightly bound as to impede the progress of any fluid within the trees, he deprived the roots and lower parts of the stems of several trees of all motion, to the height of three feet from the ground, leaving the upper parts of the stems and branches in their natural state. In the succeeding summer, much new wood accumulated in the parts which were kept in motion by the wind, but the lower parts of the stems and roots increased very little in size. Removing the bandages from one of these trees, he fixed a stake in the ground, about 10 feet distant from the tree, on the east side of it, and attached the tree to the stake, at the height of six feet, leaving it liberty to move towards the north and south, but in no other direction. Thus circumstanced, the diameter of the tree from north to south, in

that part of its stem which was most exercised by the wind, exceeded that in the opposite direction in the following autumn, in the proportion of 13 to 11.

The principal office of the horizontal branches, according to Mr. Knight, in the greatest number of trees, is to nourish and support the blossoms, and the fruit or seed; and, as these give back little or nothing to the parent tree, very feeble powers alone are wanted in the returning system. No power at all would have been fatal; and powers sufficiently strong wholly to counteract the effects of gravitation, would probably have been in a high degree destructive, and it is Mr. Knight's opinion, that the formation of blossoms may, in many instances, arise from the diminished action of the returning system in the horizontal or pendent branch.

Experiments and Calculations relative to physical Optics. By Dr. Young.

The proposition which Dr. Y. intended to establish was, "that fringes of colour are produced by the interference of two portions of light." From the experiments and calculations we may infer, that homogeneous light, at certain equal distances in the direction of its motion, is possessed of opposite qualities capable of neutralising and destroying each other; and of extinguishing the light where they happen to be united; that these qualities succeed each other alternately in successive concentric superficies, at distances which are constant for the same light passing through the same medium. From the agreement of the measures, and from the similarity of the phenomena, we may conclude that these intervals are the same as are concerned in the production of the colours of thin plates; but these are shown by the experiments of Newton to be the smaller the denser the medium; and since it may necessarily be presumed that their number must remain unaltered in a given quantity of light, it follows, of course, that light moves more slowly in a denser than in a rarer medium: and this being granted, it must be allowed that refraction is not the effect of an attractive force directed to a denser medium.

Since we know that sound diverges in concentric superficies, and that musical sounds consist of opposite qualities capable of neutralising each other, and succeeding at certain equal intervals, which are different according to the difference of the note, we are fully authorised to conclude, that there must be some strong resemblance between the nature of sound and that of light.

An Enquiry concerning the Nature of Heat, and its Mode of Communication. By BENJAMIN *Count* RUMFORD.

THE principal object of this essay is to obtain a more intimate knowledge of the nature of heat, and of its mode of action, by which the author thinks that we may be enabled to excite it with greater economy, confine it with greater facility, and direct its operations with more precision and effect.

From the first series of these experiments, he concludes that all the heat which a hot body loses when it is exposed in the air to cool, is not given off to the air which comes into contact with it, but that a large proportion of it escapes in rays, which do not heat the transparent air through which they pass, but, like light, generate heat only when and where they are stopped and absorbed.

As the results of various other experiments made with a view to determine the relative quantities of rays emitted from the surfaces of different substances, from living animals, dead animal matter, &c. we are informed that those substances which part with heat with the greatest facility are those which also acquire it most readily or with the greatest celerity; and also, that the greater the power is which an animal possesses of throwing off heat from the surface of his body, independently of that which the surrounding air takes off, the less will his temperature be affected by the occasional changes of temperature which take place in the air; and the less will he be oppressed by the intense heats of hot climates.

The warmth of any kind of substance used as clothing, or its power of preventing our bodies from being cooled by the influence of surrounding colder bodies, depends much on the polish of its surface; for, upon careful examination, it will be found that those substances which supply us with the warmest coverings, as furs, feathers, silk, &c. are not only smooth, but highly polished; it will also be found, other circumstances being equal, that those substances are the warmest which are the finest, or which are composed of the greatest number of fine polished detached threads or fibres. The fine white shining fur of a Russian hare is much warmer than coarse hair; and fine silk, as spun from the silk-worm, is warmer than the same silk twisted together into coarse threads.

Formerly Count Rumford considered the warmth of natural and artificial clothing as depending principally on the obstacle it opposed to the motions of cold air by which the hot

body is surrounded; but by a patient examination of the subject, he is now convinced that the efficacy of radiation is much greater than he had supposed it to be. Only a very small part of the heat which a hot body appears to lose, when it is cooled in the air, is, in fact, communicated to that fluid; a much greater portion of it being communicated to other surrounding bodies at a distance.

Count Rumford supposes that cold as well as hot bodies emit rays, which he denominates frigorific and caloric; and that the intensity of the rays which hot and cold bodies emit, in a medium perfectly transparent, follows the same law. He also informs us, that there are so many striking analogies between the rays of light, and those invisible rays which all bodies at all temperatures appear to emit, that there can hardly be a doubt of their motions being regulated by the same principles.

Perhaps there may be no other difference between them than exists between those vibrations in the air which are audible, and those which make no sensible impression on our organs of hearing. If the ear were so constructed that we could hear all the motions which take place in the air, we should be stunned with the noise; and if our eyes were so constructed as to see all the rays which are emitted continually by day and by night, by the bodies which surround us, we should be dazzled and confounded by that insupportable flood of light poured in upon us on every side.

In all cases where it is designed to preserve the heat of any substance which is confined in a metallic vessel, it will contribute to that end, if the external surface of the vessel be clean and bright. But if the object be to cool any thing quickly, in a metallic vessel, its external surface should be painted or covered with substances which have been found emit calorific rays in great abundance.

Polished tea-urns may be kept boiling with a much less expence of spirit of wine than such as are varnished; and the cleaner and brighter the dishes, and covers for dishes, which are used for bringing victuals to table, and for keeping it hot, the more effectually will they answer that purpose.

Saucepans and other kitchen utensils, which are very clean and bright on the outside, may be kept hot with a smaller fire, than such as are black and dirty; but the bottom of a saucepan or boiler should be blackened, in order that its contents may be made to boil quickly, and with a small expence of fuel.

When kitchen utensils are used over a fire of sea-coal or

of wood, there will be no necessity for blackening their bottoms, for they will soon be made black by the smoke; but, when they are used over a clear fire of charcoal, they should be blackened with the smoke of a lamp or coal-fire.

It has been thought that brewers' flats would answer the purpose of cooling liquors better, if made of metal, than of wood: but a metallic surface is ill calculated for expediting the emission of calorific rays. The thickness of the timber of which these tubs are commonly made, is favourable to a speedy cooling of the wort; for, when they are empty and cold, a great part of the heat of the liquor is absorbed by the wood.

Where metallic tubes, filled with steam, are used for warming rooms, the external surface of them should be painted, or covered with some substance which facilitates the emission of calorific rays. A covering of thin paper will answer the purpose very well, if it be black, and closely attached to the surface of the metal with glue.

Tubes designed for conveying hot steam from one place to another should be covered up with a warm covering, or should be kept clean and bright. It might be worth while to gild them, or to cover them with gilt paper or tin-foil, or some other metallic substance which does not easily tarnish with the air. The cylinders and principal steam-tubes of steam-engines might be covered, first with some warm clothing and then with sheet-brass, kept clean and bright. The expence of this covering would be repaid by a saving of fuel.

If garden walls painted black acquire heat faster when exposed to the sun's direct rays, they will likewise cool faster during the night, and gardeners must best determine whether these changes of temperature are or are not favourable to fruit trees.

Black clothes are known to be warm in the sun; but they are far from being so in the shade, especially in cold weather. No coloured clothing is so cold as black, when the temperature of the air is below that of the surface of the skin, and when the body is not exposed to the action of calorific rays from other substances.

The warmth of clothing depends much on the polish of the surface of the substance of which it is made; hence, in choosing winter garments, those dyes are to be avoided which tend most to destroy that polish; and as a white surface reflects more light than an equal surface equally polished, of any other colour, there is reason to think, that white garments are warmer than any other in cold weather. They are uni-

versally considered as the coolest that can be worn in very hot weather, and especially when a person is exposed to the direct rays of the sun; and if they are well calculated to reflect calorific rays in summer, they must be equally well calculated to reflect those frigorific rays by which we are cooled and annoyed in winter.

Garments of fur are warmer in cold weather when worn with the hair outwards, than when it is turned inwards. Is not this a proof that we are kept warm by our clothing, not so much by confining our heat as by keeping off those frigorific rays which tend to cool us? The fine fur of beasts, being a highly polished substance, is calculated to reflect those rays which fall on it; and if the body be kept warm by the rays which proceed from it being reflected back upon it, a fur garment would be warmest when worn with the hair inwards; but if it be by reflecting and turning away the frigorific rays from external and colder bodies, that we are kept warm by our clothes, we might expect that a pelisse would be warmest when worn with the hair outwards, as the Count says, in fact, it is.

The fur of several delicate animals becomes white in winter in cold countries; and that of bears, which inhabit the polar regions, is white in all seasons. These last are exposed alternately in the open air to the most intense cold, and to the continual action of the sun's rays during several months. If it should be true that heat and cold are excited in the manner above described, and that white is the colour most favourable to the reflection of calorific and frigorific rays, it must be acknowledged that these animals have been exceedingly fortunate in obtaining clothing so well adapted to their local circumstances.

Observations on the Change of some of the proximate Principles of Vegetables into Bitumen. By Mr. Hatchett.

Bodies, formerly appertaining to the organised kingdoms of nature, after the loss of the vital principle, become gradually converted into fossil substances. In some cases, this conversion is so complete, as to destroy all traces of previous organic arrangement; but in others the original texture and form have been more or less preserved, though the substances themselves are decidedly mineral. Some of these extraneous fossils retain part of their original principles, whilst others can only be regarded as casts or impressions. Mr. Hatchett selects from the animal kingdom, as examples, among others,

the fossil ivory, which retains its cartilage; the bones in the Gibraltar rock, consisting of little more than the earthy part or phosphate of lime. The vegetable kingdom has likewise produced many striking instances; and animal petrifactions are commonly of a calcareous nature, but vegetable petrifactions are generally siliceous.

Mr. Hatchett's main object is to adduce some proofs, that the bituminous substances are derived from the organised kingdoms of nature, and especially from vegetable bodies. The chemical characters of the pure or unmixed bitumens, such as naphtha, mineral tar, &c. are, in certain respects, so different from those resins and other inspissated juices of recent vegetables, that, had the former never occurred but in a separate and unmixed state, no positive inference could have been drawn from their properties, in proof of their vegetable origin. Fossil animal substances form a series, commencing with such as are scarcely different from those which are recent, and terminating in productions which have totally lost all traces of organisation.

Similar instances are afforded by the vegetable kingdom: the three examples cited in this paper are, 1. The submarine forest at Sutton, on the coast of Lincolnshire, the timber of which has not suffered any very apparent change in its vegetable characters. 2. The strata of bituminous wood, called Bovey coal, found at Bovey, in Devon, which exhibits a series of gradations, from the most perfect ligneous texture, to the substance nearly approaching the characters of pit-coal, and, on that account, distinguished by the name of stone-coal. 3. The varieties of pit-coal, so abundant in many parts of this country, in which almost every appearance of vegetable has been destroyed.

These examples appear to form the extremities and centre of the series; but as the process of carbonisation, and formation of bitumen, has not taken place in the first instance, and as these effects have proceeded to the ultimate degree in the last, it seems most proper to seek for information, and for positive evidence, in the second example, which appears to be the mean point, exhibiting effects of natural operations, by which bitumen and coal have been imperfectly and partially formed, without the absolute obliteration of the original vegetable characters.

After a minute and accurate description and analysis of the bitumen from Bovey coal, it is inferred by Mr. Hatchett, that it is a peculiar and hitherto unknown substance, which is partly in the state of vegetable resin, and partly in that of

the bitumen called asphaltum, the resin being in the largest proportion, as 100 grains of it afforded: —

Resin - - - -	55
Asphaltum - - -	41
Earthy residuum - - -	3
	99

Thus we have an instance of a substance being found under circumstances which constitute a fossil, although the characters of it appertain partly to the vegetable and partly to the mineral kingdom.

Time alone does not reduce animal or vegetable bodies to the state of fossils. There are examples of whole forests which have been submerged prior to any tradition, and which, nevertheless, completely retain their ligneous characters. Other causes and agents must therefore have been required to form the varieties of coal, and other bituminous substances. In some instances, as in the formation of Bovey coal, these causes seem to have acted partially and imperfectly, while, in the formation of the greater part of the pit-coals, their operation has been extensive and complete.

In the pit-coals, the mineral characters predominate, and the principal vestige of their real origin seems to be bitumen, for the presence of carbon in the state of oxide cannot alone be considered as decisive. Bitumen, therefore, with the exuviæ and impressions so commonly found in the accompanying strata, must be regarded as proofs in favour of the origin of pit-coal from organised bodies; and, considering the general facts, which have been long observed, together with those lately adduced respecting the Bovey coal, and the substance found with it, we seem to have evidence, that bitumen has been produced by the modification of some of the proximate principles of vegetables, and especially resin.

On Muscular Motions. By ANTHONY CARLISLE, *Esq.*

MUSCULAR motion is the first sensible operation of animal life: the various combinations of it sustain and carry on the multiplied functions of the largest animals: the temporary cessation of this motive faculty is the suspension of the living powers; its total quiescence is death.

The muscular parts of animals are most frequently composed of many substances in addition to those which are purely muscular. In this gross state, they constitute a flex-

ible, compressible solid, whose texture is generally fibrous, the fibres being compacted into fasciculi, or bundles of various thickness. These fibres are elastic during the contracted state of the muscles after death, being capable of extension to more than one-fifth of their length, and of returning again to their former state of contraction. This elasticity, however, appears to belong to the cellular membrane, and not to the matter of the muscle.

The attraction of cohesion, in the parts of the muscle, is strongest in the fibres, being double that of the transverse direction. When muscles are capable of reiterated contractions and relaxations, they are said to be alive, or to possess irritability. This quality fits the organ for its functions. When muscles have ceased to be irritable, their cohesive attraction in the direction of their fibres is diminished, but it remains unaltered in the transverse direction.

In speaking of temperature as having an essential influence over the actions of the muscles, and of respiration as one of the known causes which influences the temperatures of animals, the following facts deserve notice: —

Diminished respiration is the first step into the state of torpidity: a deep sleep accompanies it; respiration then ceases altogether; the animal temperature is totally destroyed, coldness and insensibility take place, and finally, the heart concludes its motions, and the muscles cease to be irritable. It is worthy of remark, that a confined air, and a confined respiration, ever precede these phenomena: the animal retires from the open atmosphere, his mouth and nostrils are brought into contact with his chest, and enveloped in fur; the limbs become rigid, and the blood never coagulates during the dormant state. On being roused, the animal yawns, the respirations are fluttering, the heart acts slowly and irregularly, he begins to stretch out his limbs, and proceeds in quest of food. During this dormancy, the animal may be frozen, without the destruction of the muscular irritability, and this always happens to the garden snail, and to the chrysalides of many insects during the winter of this climate.

The loss of motion and sensation, from the influence of lower temperature, accompany each other, and the capillaries of the vascular system appear to be contracted by the loss of animal heat, as in the examples of numbness from cold. Whether the cessation of muscular action be owing to the impeded influence of the nerves, or to the lowered temperature of the muscles themselves, is doubtful; but the known influence of cold upon the sensorial system, rather favours

the supposition, that a certain temperature is necessary for the transmission of nervous influence, as well as sensation.

From other experiments, it appears that the irritability of the heart is inseparably connected with respiration; and that, according to the nature of the inhaled gas, the actions of the heart are altered or suspended, and the whole muscular and sensorial systems partake of the disorder. The blood appears to be the medium of conveying heat to the different parts of the body, and the changes of animal temperature connected with the degree of rapidity of the circulation.

In considering the causes which occasion the loss of muscular irritability, we are referred to workmen whose hands are exposed to the contact of white lead, the torpidity of whose muscles seems to be decidedly local, because, in many instances, neither the brain nor the other members partake of the disorder, and it generally affects the right hand. A chemist has frequently experienced spasms and rigidity in the muscles of his fore arms, from the effusions of nitric acid over the cuticle of the hand and arm. The use of mercury occasionally brings on a similar rigidity in the masseter muscles.

A smaller quantity of blood flows through a muscle during the state of contraction than during the quiescent state, as is evinced by the pale colour of the red muscles when contracted. But when the muscles are vigorously contracted, their sensibility to pain is nearly destroyed: this mean is employed by jugglers, for the purpose of suffering pins to be thrust into the calf of the leg and other muscular parts with impunity.

The human muscles are susceptible of changes from extraordinary occurrences of sensible impressions. Long attention to interesting visible objects, or to audible sensations, exhausts muscular strength: intense thought and anxiety weaken the muscular powers, and the passions of grief and fear produce the same effect suddenly, while the contrary feelings give more than ordinary vigour. To conclude: there are two states of the muscles; one active, or that of contraction; the other a state of ordinary tone, which may be considered as passive, as far as relates to the mind; but the nervous power seems never to be quiescent, as it respects either the voluntary or involuntary muscles during life. The yielding of the sphincters appears to depend on their being overpowered by antagonist muscles rather than on voluntary relaxation.

On the Sap of Trees. By AND. KNIGHT, *Esq.*

THE sap in trees in an inspissated state, or some concrete matter deposited by it, exists during the winter in the alburnum or sapwood, and from this fluid or substance, dissolved in the ascending aqueous sap, is derived the matter which enters into the composition of the new leaves in the spring, and thus furnishes those organs which were not nted during the winter, but which are essential to the fur- er progress of vegetation. Hence, the superiority of winter-felled wood, which has generally been attributed to the absence of the sap at that season, is owing to the substance that has been added to it instead of taken from it.

Bulbous and tuberous roots are almost wholly generated after the leaves and stems of the plants to which they belong have attained their full growth; hence, the produce of meadows is greatly increased when the herbage of the preceding year remained to perform its proper office till the end of the autumn, on ground which had been mowed early in the summer. On this account Mr. Knight infers, 'that the leaves both of trees and herbaceous plants are alike employed during the latter part of summer, in the preparation of matter calculated to afford food to the expanding buds and blossoms of the succeeding spring, and to enter into the composition of new organs of assimilation.' In proof of this hypothesis Mr. Knight made many experiments, an account of which he has, by means of this letter, laid before the Royal Society.

The evidence that bulbous and tuberous rooted plants contain matter within themselves is decisive; for they vegetate even in dry rooms on the approach of spring; and many bulbous rooted plants produce their leaves and flowers with nearly the same vigour by the application of water only, as they do when growing in the best mould. The water probably acts only by dissolving the matter prepared and deposited in the preceding year, and hence the root becomes exhausted and spoiled; and it has been found, that the leaves and flowers and roots of such plants afforded no more carbon than exist in bulbous roots of the same weight, the leaves and flowers of which had never expanded.

From experiments made with care, Mr. Knight infers, that the reservoir of matter, deposited in the alburnum, is not wholly exhausted in the succeeding spring, from which circumstance he accounts for the several successions of leaves and buds which trees are capable of producing, when those previously protruded have been destroyed by insects or other

causes; and for the luxuriant shoots which often spring from the trunks of the trees whose branches have been long in a state of decay. He thinks, that the alburnum remains unemployed in some cases during several successive years, since it is not probable that it can be employed by trees, which, after having been transplanted, produce very few leaves, or by those which produce neither blossoms nor fruit. In the year 1802, Mr. Knight cut off in the winter all the branches of a pear-tree, supposed to be nearly 200 years old, and whose extremities were generally dead; he pared off, at the same time all the lifeless external bark. No marks of vegetation appeared in the following spring; but in July numerous buds penetrated through the bark, and in the autumn every part was covered with shoots about two feet in length. The number of leaves and branches appeared to exceed the whole of those which the tree had borne the three preceding seasons, which could scarcely have been wholly prepared by the scanty vegetation and foliage of the preceding year

As inferences from his experiments, Mr. Knight concludes that the fluid which enters into and circulates through the leaves of plants, as the blood through the lungs of animals, consists of a mixture of the true sap or blood of the plant, with matter more recently absorbed and less perfectly assimilated. It is probable that the true sap undergoes a considerable change on its mixture with the ascending aqueous sap; and that the saccharine matter, existing in the ascending sap, is not wholly derived from the fluid which had circulated through the leaf in the preceding year, but that it is generated by a process similar to that of the germination of seeds, and that the same process is always going forward during the spring and summer, as long as the tree continues to generate new organs. But towards the conclusion of the summer, the true sap simply accumulates in the alburnum, and thus adds to the specific gravity of winter-felled wood, and increases the quantity of its extractive matter. And he adds, "If subsequent experiments prove that the true sap descends through the alburnum," as he suspects to be the case, "it will be easy to point out the cause why trees continue to vegetate after all communication between the leaves and roots, through the bark, has been intercepted; and why some portion of alburnous matter is in the trees generated below incision through the

On the Direction of the Sun and Solar System. By Dr. HERSCHEL.

THE learned astronomer conceived, more than twenty years ago, that it was highly probable there was a motion of the sun and solar system towards λ Herculis; and he says, the reasons which were in 1783 pointed out for introducing a [illegible] motion, will now be much strengthened by other con[illegible]ations. He conceives that the motion of the sun and system will account for the apparent motions of the larger fixed stars upon much the easiest principles. Thus, by admitting a motion of the sun towards λ Herculis, the annual motions of six stars, viz., Sirius, Arcturus, Capella, Lyra, Aldebaran, Procyon, may be reduced to little more than 2″, whereas the sum of them would be 5″.3537; and, by another table, founded on a calculation of the angles, and the least quantities of real motion of the same six stars, it appears that the annual proper motion of the stars may be reduced to 1″.4594, which is 0″.7635 less than the sum in the former case.

On the singular Figure of the Planet Saturn. By Dr. HERSCHEL.

THERE is not, perhaps, another object in the heavens that presents us with such a variety of extraordinary phenomena as the planet Saturn. A magnificent globe, encompassed by a stupendous double ring, attended by seven satellites, ornamented with equatorial belts, compressed at the poles; turning upon its axis, mutually eclipsing its ring and satellites, and eclipsed by them; the most distant of the rings also turning upon its axis, and the same taking place with the farthest of the satellites: all the parts of the system of Saturn occasionally reflecting light to each other, the rings and moons illuminating the nights of the Saturnian, the globes and satellites enlightening the dark parts of the rings; and the planet and rings throwing back the sun's beams upon the moons, when they are deprived of them at the time of conjunction.

Besides these circumstances, which appear to leave hardly any room for addition, there is yet a singularity left, which distinguishes the figure of Saturn from that of all the other planets. It is flattened at the poles, but the spheroid that would arise from this flattening is modified by some other cause, which Dr. H. supposes to be the attraction of the ring. It resembles a parallelogram, one side of which is the equa-

torial, the other the polar diameter, with the four corners rounded off, so as to leave both the equatorial and polar regions flatter than they would be in a regular spheroidical figure.

On the Reproduction of Buds. By Mr. KNIGHT.

EVERY tree, in the ordinary course of its growth, generates in each season those buds which expand in the succeeding spring, and the buds thus generated contain, in many instances, the whole leaves which appear in the following summer. But if these buds be destroyed in the winter, or early part of the spring, other buds, in many species of trees, are generated, which in every respect perform the office of those which previously existed, except that they never afford fruit or blossoms.

He then proceeds to mention different theories to account for this; and, as his own opinion, he says, that the buds neither spring from the medulla nor the bark, but are generated by central vessels, which spring from the lateral orifices of the alburnous tubes. The practicability of propagating some plants from their leaves may seem to stand in opposition to this hypothesis; but the central vessel is always a component part of the leaf, and from it the bud and young plant probably originate.

Mr. K. thinks that few seeds contain less than three buds, one of which only, except in cases of accident, germinates. Some seeds contain a much greater number. The seed of the peach appears to be provided with ten or twelve leaves, each of which probably covers the rudiment of a bud, and the seeds, like the buds of the horse-chesnut, contain all the leaves, and apparently all the buds, of the succeeding year.

Differences in the Magnetic Needle on board His Majesty's Ship the Investigator, arising from an Alteration in the Direction of the Ship's Head. By Captain FLINDERS.

THERE was a difference in the direction of the magnetic needle when the ship's head pointed to the east, and when it was directed westward.

This difference was easterly when the ship's head was west, and westerly when it was east.

When the ship's head was north or south, the needle took the same direction, or nearly so, that it would on shore, and showed a variation from the true meridian.

The error in variation was nearly proportionate to the

number of points which the ship's head was from north or south.

Hence the captain supposes, 1. An attractive power of the different bodies in a ship, which are capable of affecting the compass, to be collected into something like a focal point or centre of gravity, and this point is nearly in the centre of the ship, where the iron shot are deposited. 2. He supposes this point to be endued with the same kind of attraction as the e of the hemisphere where the ship is: consequently, in Holland, the south-end of the needle would be attracted by it, and the north end repelled. 3. That the attractive power of this point is sufficiently strong in a ship of war to interfere with the action of the magnetic poles upon a compass placed upon or in the binnacle.

On the Arrangment and Mechanical Action of the Muscles of Fishes. By ANTHONY CARLISLE, Esq.

THE muscles of fishes are of a very different construction from those of the other natural classes. The medium in which these animals reside, the form of their bodies, and the instruments employed for their progressive motion, give them a character peculiarly distinct from the rest of the creation. The frame-work of bones or cartilages is simple; the limbs are not formed for complicated motions; and the proportion of muscular flesh is remarkably large. The muscles of fishes have no tendinous chords, their insertions being always fleshy. There are, however, semi-transparent pearly tendons placed between the plates of the muscles, which give origin to a series of short muscular fibres passing nearly at right angles between the surfaces of the adjoining plates.

The motion of a round-shaped fish, independent of its fins, is simple: it is chiefly effected by the lateral flexure of the spine and tail, upon which the great mass of its muscular flesh is employed, whilst the fins are moved by small muscles, and those, from their position, comparatively but of little power.

Mr. C. first describes the fins, the purposes to which they are employed, and the muscles attached to them; and then, in order to ascertain the effect of the fins on the motions of fishes, he performed a variety of experiments. A number of living dace, of an equal size, were put into a large vessel of water. The pectoral fins of one of these were cut off, and it was replaced with the others; its progressive motions were not at all impeded, but the head inclined downwards, and

when it attempted to ascend, the effort was accomplished with difficulty.

The pectoral and abdominal fins were then removed from a second fish. It remained at the bottom of the vessel, and could not be made to ascend. Its progressive motion was not perceptibly more slow; but when the tail acted, the body showed a tendency to roll; and the single fins were widely expanded, as if to counteract this effect.

From a third fish the single fins were taken off, which duced a tendency to turn round, and the pectoral fins kept constantly extended to obviate that motion.

From a fourth fish the pectoral and abdominal fins were cut off on one side, and it immediately lost the power of keeping its back upwards. The single fins were expanded; but the fish swam obliquely on its side, with the remaining pectoral and abdominal fins downwards.

From a fifth fish all the fins were removed. Its back was kept in a vertical position, whilst at rest, by the expansion of the tail; but it rolled half round at every attempt to move.

From a sixth fish the tail was cut off close to the body. Its progressive motion was considerably impeded, and the flexions of the spine were much increased during the endeavour to advance; but neither the pectoral nor abdominal fins seemed to be more actively employed.

From a seventh fish all the fins and the tail were removed. It remained almost without motion, floating near the surface of the water, with its belly upward.

These experiments were repeated on the roach, the gudgeon, and the minnow, with similar results.

The next observation relates to the velocity of fishes, which, being but little less than that of the flight of the swiftest birds, is very remarkable, considering the density of the medium in which they swim. And although the large proportion of muscles, and their advantageous application, may partly account for the phenomenon, yet the power would be inadequate to the effect, if it were not suddenly enforced, as is evident from the slow progress of eels, and such fishes as are incapable, from their length and flexibility, of giving a sudden lateral stroke.

The quickness and force of the action in the muscles of fishes are counterpoised by the short duration of their powers. The shortness of the muscular fibres, and the multiplied ramis of the blood-vessels, are probably peculiar adaptations e purpose of gaining velocity of action, which seems to variably connected with a very limited duration of it. Such

examples form an obvious contrast with the muscular structure of slow-moving animals, and with those partial arrangements where unusual continuance of action is concomitant.

On the Quantity and Velocity of the Solar Motion. By Dr. Herschel.

As the result of his several speculations, Dr. Herschel observes, that it appears, in the present state of our knowledge of the observed proper motions of the stars, we have reason to fix upon the quantity of the solar motion to be such as by an eye, placed at right angles to its direction, and at the distance of Sirius from us, would be seen to describe annually an arc of 1″.116992 of a degree, and its velocity, till we are acquainted with the real distance of this star, can only be expressed by the proportional number 1,116,992.

The apparent velocities of Arcturus and Aldebaran, without a solar motion, were supposed, by a table already referred to, as 208 to 12; but when the deception arising from its parallactic effect is removed by calculation, these velocities are to each other only as 179 to 85, or as 2 to 1: and though Arcturus still remains a star that moves with great velocity, yet there are by the table four or five stars with nearly as much motion, and four with more. This solar motion also removes the deception by which the motion of a star of the consequence of λ Orionis is so concealed as hardly to show any velocity; whereas, by computation, we find that it really moves at a rate which is fully equal to the motion of the sun.

The similarity of the directions of the sidereal motions is an indication that the stars, having such motions as well as the sun, are acted upon by some connecting cause, which can only be attraction; and as attraction will not explain the observed phenomena without the existence of projectile motions, it must be admitted that the motions of the stars are governed by the same two ruling principles which regulate the orbitual motions of the bodies of the solar system. It must also be admitted, that we may invert the inference from the operation of these causes in our system, and conclude that their influence upon the sidereal motions will tend to produce a similar effect; by which means the probable motion of the sun and of the stars in orbits becomes a subject that may receive the assistance of arguments supported by observation.

Observations and Remarks on the Figure, Climate, and Atmosphere of Saturn and its Ring. By Dr. HERSCHEL.

IT is known that the axis of the planet's equator, as well as that of the ring, keeps its parallelism during the time of its revolution about the sun; and hence it follows, that the same change of situation, by which the ring is affected, must also produce similar alterations in the appearance of the planet but since the shape of Saturn, though not strictly spherical, very different from that of the ring, the changes occasioned by its aspects will be so minute that they only can expect to perceive them who have been accustomed to look at very small objects, and who are furnished with instruments that will show them distinctly, with a high and luminous magnifying power.

In the year 1789, Dr. Herschel ascertained the proportion of the equatorial to the polar diameter of Saturn to be 22.81 to 20.61: in this measure was included the effect of the ring on the figure of the planet, though its influence had been investigated by direct observation. The rotation of the planet was determined afterwards by changes observed in the configuration of the belts.

The flattening at the poles of Saturn is more extensive than it is on the planet Jupiter. The curvature in high latitudes is also greater than on that planet. At the equator, on the contrary, the curvature is rather less than it is on Jupiter. Upon the whole, therefore, the shape of the globe of Saturn is not such as a rotatory motion alone could have given it.

From the latest observations it is inferred: 1. that the breadth of the ring is to the space between the ring and the planet, as about five to four. 2. The ring appears to be sloping towards the body of the planet, and the inside edge of it is probably of a spherical, or perhaps hyperbolical, form. 3. The shadow of the ring on the planet is broader on both sides than in the middle: this partly is a consequence of the curvature of the ring, which in the middle of its passage across the body hides more of the shadow in that place than at the sides. 4. The shadow of the body upon the ring is a little broader at the north than the south, so as not to be parallel with the outline of the body; nor is it so broad at the north as to become square with the direction of the ring. 5. The most northern dusky belt comes northwards on both sides as far as the middle of the breadth of the ring, where it passes behind the body. It is curved towards the south in the middle.

Observations on the Camel's Stomach, respecting the Water it contains, and the Reservoirs in which that Fluid is enclosed. By Mr. Everard Home.

The camel, the subject of these observations, was a female brought from Arabia; it was 28 years old, and said to have been 20 years in England. It appears that the animal was worn out, and in a state of great debility, before it came into the hands of the college of surgeons, and in April last they put an end to its miseries, by means of a narrow double-edged poniard, passed in between the skull and first vertebra of the neck: in this way the medulla oblongata was divided, and the animal instantaneously deprived of sensibility. "In the common mode of *pithing* an animal," says Mr. Home, "the medulla spinalis only is cut through, and the head remains alive, which renders it the most cruel mode of killing an animal that could be invented." The stomachs of this animal were the first things examined, and on measuring the capacities of these different reservoirs in the dead body, the anterior cells of the first stomach were found capable of containing one quart of water, when poured into them. The posterior cells three quarts. One of the largest cells held two ounces and a half, and the second stomach four quarts. This is much short of what those cavities can contain in the living animal, since there are large muscles covering the bottom of the cellular structure, to force out the water, which must have been contracted immediately after death, and by that means had diminished the cavities. By this examination it was proved, that the camel, when it drinks, conducts the water in a pure state into the second stomach, that part of it is retained there, and the rest runs over into the cellular structure of the first, acquiring a yellow colour.

The camel's stomach anteriorly forms one large bag, but when laid open, is found to be divided into two compartments on its posterior part, by a strong ridge, which passes down from the right side of the orifice of the œsophagus, in a longitudinal direction. On the left side of the termination of the œsophagus, a broad muscular band has its origin, from the coats of this first stomach, and passes down in the form of a solid parallel to the great ridge, till it enters the orifice of the second stomach. This band on one side, and the great ridge on the other, form a canal, which leads from the œsophagus down to the cellular structure in the lower part of the first stomach. The orifice of the second stomach, when this muscle is not in action, is nearly shut, and at right angles

to the side of the first. Its cavity is a pendulous bag, with rows of cells, above which, between them and the muscle *which passes along the upper part of the stomach, is a smooth surface extending from the orifice of this stomach to the termination in the third.* Hence it is evident, that the second stomach neither receives the solid food in the first instance, as in the bullock, nor does it afterwards pass into its cavity or cellular structure. The food first passes into the general cavity of the first stomach, and that portion of it which lies in the recess immediately below the entrance of the œsophagus, under which the cells are situated, is kept moist, and is readily returned into the mouth, so that the cellular portion of the first stomach in the camel performs the same office as the second in the ruminants with horns. While the camel is drinking, the action of the muscular band opens the orifice of the second stomach, at the same time that it directs the water into it; and when the cells of that cavity are full, the rest runs off into the cellular structure of the first stomach immediately below, and afterwards into the general cavity: it seems that camels, when accustomed to go long journeys, in which they are kept without water, acquire the power of dilating the cells, so as to make them contain a more than ordinary quantity as a supply for their journey. When the cud has been chewed, it has to pass along the upper part of the second stomach before it can reach the third, which is thus managed: at the time that the cud is to pass from the mouth, the muscular band contracts with so much force, that it not only opens the orifice of the second stomach, but acting on the mouth of the third, brings it forwards into the second, by which means the muscular ridges that separate the rows of cells are brought close together, so as to exclude these cavities from the canal through which the cud passes. "It is this beautiful and very curious mechanism," says Mr. Home, "which forms the peculiar character of the stomach of the camel, dromedary, and lama, fitting them to live in the sandy deserts where the supplies of water are so precarious."

From the comparative view which Mr. Home has taken of the stomachs of the bullock and camel, it appears, that in the bullock there are three stomachs formed for the preparation of food, and one for digestion. In the camel, there is one stomach fitted to answer the purposes of two of the bullock; a second is employed as a reservoir for water, having nothing to do with the preparation of the food; a third is so small and simple in its structure, that it is not easy to ascertain its particular office.

Observations on a late Comet, made with a View to investigate its Magnitude, and the Nature of its Illumination. By Dr. Herschel.

Oct. 4. I viewed the comet with different magnifying powers, but found that its light was not sufficiently intense to bear very high ones. As far as 200 and 300, my ten-feet reflector acted very well; but with 400 and 500 there was nothing gained, because the exertion of a power depending on the quantity of light was obstructed, which I found was here of greater consequence than the increase of magnitude.

Magnitude of the Nucleus. — Oct. 26. In order to see the nucleus as small as it really is, we should look at it a long while, that the eye may gradually lose the impression of the bright coma which surrounds it. This impression will diminish gradually; and when the eye has got the better of it, the nucleus will then be seen most distinctly, and of a determinate magnitude.

Oct. 4. With a seven feet reflector, I estimated the diameter of the nucleus of the comet at first to be about five seconds; but soon after I called it four, and by looking at it longer I supposed it could not exceed three seconds.

Of the Head of the Comet. — When the comet is viewed with an inferior telescope, or if the magnifying power, with a pretty good one, is either much too low, or much too high, the very bright rays immediately contiguous to the nucleus will seem to belong to it, and form what may be called the head.

Oct. 19. I examined the head of the comet with an indifferent telescope, in the manner I have described, and found it apparently of the size of the planet Jupiter, when it is viewed with the same telescope and magnifying power. With a good telescope, I saw, in the centre of the head, a very small, well-defined round point.

Of the Coma of the Comet. — Oct. 19. By the field of view of my reflector, I estimate the coma of the comet to be about six minutes in diameter.

Dec. 6. The extent of the coma, with a mirror of 24 inches diameter, is now about 4.15.

Of the Tail of the Comet. — Oct. 18. 7h. With a night-glass, which has a field of view of nearly 5°, I estimated the length of the tail to be 3½°; but twilight is still very strong, which may prevent my seeing the whole of it.

Oct. 28. Seven-feet reflector. The south preceding side of the tail in all its length, except towards the end, is very well defined; but the north-following side is every where

hazy and irregular, especially towards the end; it is also shorter than the south-preceding one.

A visible, round, and well-defined disk, shining in every part of it with equal brightness, elucidates two material circumstances; for since the nucleus of this comet, like the body of a planet, appeared in the shape of a disk, which was experimentally found to be a real one, we have good reason to believe that it consists of some condensed or solid body, the magnitude of which may be ascertained by calculation.

We are authorised to conclude, that the body of the comet on its surface is self-luminous, from whatever cause this quality may be derived. The vivacity of the light of the comet also had a much greater resemblance to the radiance of the stars, than to the mild reflection of the sun's beams from the moon, which is an additional support to our former inference.

The changes in the brightness of the small stars, when they are successively immerged in the tail or coma of the comet, or clear from them, prove evidently that they are sufficiently dense to obstruct the free passage of star-light. Indeed, if the tail or coma were composed of particles that reflect the light of the sun to make them visible, we ought rather to expect that the number of solid reflecting particles, required for this purpose, would entirely prevent our seeing any stars through them. But the brightness of the head, coma, and tail alone, will sufficiently account for the observed changes, if we admit that they shine not by reflection, but by their own radiance; for a faint object projected on a bright ground, or seen through it, will certainly appear somewhat fainter, although its rays should meet with no obstruction in coming to the eye.

The immense tails of some comets that have been observed, and even that of the present one, which on the 18th of October was expanded over a space of more than 9,000,000 of miles, may be accounted for more satisfactorily, by admitting them to consist of radiant matter, such as, for instance, the aurora borealis, than when we unnecessarily ascribe their light to a reflection of the sun's illumination thrown upon vapours supposed to arise from the body of the comet.

Experiments made with a View of ascertaining the Changes produced in Atmospheric Air and Oxygen Gas by Respiration. By Messrs. Allen and Pepys.

They prove that the quantity of carbonic acid gas emitted, is exactly equal, bulk for bulk, to the oxygen consumed; and

therefore there is no reason to conjecture, that any water is formed by a union of oxygen and hydrogen in the lungs.

Atmospheric air, once entering the lungs, returns charged with from 8 to 8½ per cent. of carbonic acid gas; and when the contacts are repeated almost as frequently as possible, only 10 per cent. is emitted.

It appears that a middle-sized man, aged 38 years, and whose pulse is 70 on an average, gives off 302 cubical inches of carbonic acid gas from his lungs in 11 minutes; and supposing the production uniform for 24 hours, the total quantity in that period would be 39,534 cubical inches, weighing 18,683 grains, the carbon in which is 5,363 grains, or rather more than 11 ounces troy. The oxygen consumed in the same time will be equal in volume to the carbonic acid gas. The quantity of carbonic acid gas, emitted in a given time, must depend much on the circumstances under which respiration is performed.

When respiration is attended with distressing circumstances, there is reason to conclude, that a portion of oxygen is absorbed: and as the oxygen decreases in quantity, perception gradually ceases, and we may suppose, that life would be completely extinguished on the total abstraction of oxygen.

A larger proportion of carbonic acid gas is formed by the human subject from oxygen than from atmospheric air.

An easy natural inspiration is from 16 to 17 cubical inches, though this will differ in different subjects; and it is supposed that the quantity of carbonic acid gas, given off in a perfectly natural respiration, ought to be reckoned at less than at a time when experiments are making on the human subject for the purpose, because in short inspirations the quantity of air, which has reached no farther than the fauces, trachea, &c., bears a much larger proportion to the whole mass required than when the inspirations are deep.

No hydrogen, nor any other gas, appears to be evolved during the process of respiration.

The general average of the deficiency in the total amount of common air inspired, appears to be very small, amounting only to 6 parts in 1000.

The experiments upon oxygen gas prove, that the quantity of air remaining in the lungs and its appendages is very considerable; and that without a reference to this circumstance, all experiments upon small quantities of gas are liable to inaccuracy.

Account of the Origin and Formation of Roots. By Mr. Knight.

FORMER experiments had led him to conclude, that the buds of trees invariably spring from the alburnum, to which they are always connected by central vessels of greater or less length; and in the present discussion he means to show, that the roots of trees are generated by the vessels which pass from the cotyledons of the seed, and from the leaves, through the leaf-stalks and the bark, and that they never, under any circumstances, spring immediately from the alburnum.

The radicle in the seed has been generally supposed to be analogous to the root of the plant, and to become a perfect root during germination: this opinion Mr. Knight supposes to be founded in error. "A root," he says, "in all cases with which I am acquainted, elongates only by new parts, which are successively added to its apex, and never, like the stem or branch by the extension of parts previously organised;" and it is owing to this difference in the mode of growth of the root, and lengthened plumule of germinating seeds, that the one must be ever obedient to gravitation, and point to the centre of the earth, while the other must take the opposite direction. But the radicle of germinating seeds elongates by the extension of parts previously organised; and, in many cases, raises the cotyledons out of the mould in which the seed is placed to vegetate. The mode of growth of the radicle, is, therefore, similar to that of the substance which occupies the spaces between the buds near the point of the succulent annual shoot, and totally different from that of the proper root of the plant, which comes into existence during the germination of the seed, and springs from the point of the radicle. At this period, neither the radicle nor cotyledons contain any alburnum, and therefore the first root cannot originate from that substance; but the cortical vessels are then filled with sap, and apparently in full action, and through these the sap appears to descend, which gives existence to the true root. When first emitted, the root consists only of a cellular substance, similar to that of the bark of other parts of the future tree, and within this the cortical vessels are subsequently generated in a circle, inclosing within it a small portion of the cellular substance, which forms the pith or medulla of the root. The cortical vessels soon enter on their office of generating alburnous matter; and a transverse section of the root then shows the alburnum arranged

in the form of wedges round the medulla, as it is subsequently deposited on the central vessels of the succulent annual shoot, and on the surface of the alburnum of the stems and branches of older trees.

If a leaf-stalk be deeply wounded, a cellular substance, similar to that of the bark and young root, is protruded from the upper lip of the wound, but never from the lower; and the leaf-stalks of many plants possess the power of emitting roots, which power cannot have resided in the alburnum, for the leaf-stalk contains none; but vessels, similar to those of the bark and radicle, abound in it, and apparently convey the returning sap; and from these vessels, or from the fluid which they convey, the roots emitted by the leaf-stalk derive their existence. If a portion of the bark of a vine be taken off in a circle, extending round its stem, so as to intercept entirely the passage of any fluid through the bark, and any body which contains much moisture be applied, numerous roots will soon be emitted into it, immediately above the decorticated space, but never immediately beneath it; and when the alburnum in the decorticated spaces has become lifeless to a considerable depth, buds are usually protruded beneath, but never immediately above it, apparently owing to the obstruction of the ascending sap. The roots which are emitted in the preceding case do not appear in any degree to differ from those which descend from the radicles of generating seeds, and both apparently derive their matter from the fluid which descends through the cortical vessels.

Mr. K. anticipated the result of this and other experiments mentioned by him; "not," says he, "that I supposed that roots can be changed into buds, or buds into roots; but I had before proved, that the organisation of the alburnum is better calculated to carry the sap it contains from the root upwards than in any other direction; and I concluded, that the sap, when arrived at the top of the cutting through the alburnum, would be there employed in generating buds, and that these buds would be protruded where the bark was young and thin, and consequently afforded little resistance: I had also proved that bark to be better calculated to carry the sap towards the roots than in the opposite direction; and I thence inferred, that as soon as any buds, emitted by cuttings, afforded leaves, the sap would be conveyed from these to the lower extremity of the cuttings by the cortical vessels, and be there employed in the formation of roots."

Both the alburnum and bark of trees contain their true sap; and as this, like the animal blood, is probably filled with par-

ticles which are endued with life, Mr. K. conjectures, that the same fluid, by acquiring different motions, may generate different organs than that two distinct fluids should be necessary to form the root, and the bud and leaf. When alburnum is formed in the root, that organ possesses, in common with the stem and branches, the power of producing buds and of emitting fibrous roots, and when it is detached from the tree, the buds always spring near its upper end, and the roots near the opposite extremity. The alburnum of the root is also similar to that of other parts of the tree, except that it is more porous, probably owing to the presence of abundant moisture during the period in which it is deposited. Perhaps the same cause may retain the wood of the root permanently in the state of alburnum; for if the mould be taken away, so that the parts of the larger roots which adjoin the trunk be exposed to the air, such parts are subsequently found to contain much heart wood.

In opposition to the opinion, that fibrous, like bulbous roots, of all plants, are only of annual duration, it is observed that, with regard to the latter, nature has provided a distinct reservoir for the sap, which is to form the first leaves and fibrous roots of the succeeding season; but the organisation of trees is different, and the alburnum and bark of the roots and stems of these are the reservoirs of their sap during winter. When, however, the fibrous roots of trees are crowded together in a garden-pot, they are often found lifeless in the succeeding spring; but this mortality does not occur in the roots of trees when growing under favourable circumstances in their natural situation.

Experiments on the most advantageous Method of constructing Voltaic Apparatus. By Mr. John George Children.

His battery consisted of upwards of 92,000 square inches in surface, each plate being four feet by two; and it was charged with a mixture of three parts of fuming nitrous, and one part of sulphuric acid, diluted with 30 parts of water With this battery he fused completely 18 inches of platina wire, $\frac{1}{30}$th of an inch in diameter, in 20 seconds, and 10 inches of iron wire, $\frac{1}{70}$th of an inch thick: charcoal was burnt, giving out an intense brilliancy. But on imperfect conductors it had not the slightest effect; and on the human body it was hardly perceptible; and it had scarcely any effect on the gold leaves of an electrometer.

But with a second battery, consisting of 200 pair of plates,

each about two inches square, placed in half-pint pots of common queen's-ware, and rendered active by some of the liquor used in exciting the large battery, to which was added a small portion of fresh sulphuric acid, he readily decomposed potash and barytes: in that state it produced the metallisation of ammonia with great facility; it ignited charcoal vividly; it caused great divergence in the leaves of an electrometer; and it gave a vivid spark after being in action three hours.

Hints on the Subject of Animal Secretions, with a View of throwing new Lights on Animal Chemistry. By Mr. Everard Home.

The discoveries of Mr. Davy suggested to Mr. Home the idea, that the animal secretions may be produced by chemical changes effected by the power of electricity.

The voltaic battery, he observes, is met with in the torpedo and electrical eel, a circumstance that furnishes two important facts: one, that a voltaic battery can be formed in a living animal; the other, that nerves are essentially necessary for its management; for in these fish, the nerves connected with the electrical organs exceed those that go to all the other parts of the fish, in the proportion of twenty to one. The nerves are made up of an infinite number of small fibres, a structure so different from that of the electric organ, that they are evidently not fitted to form a voltaic battery of high power: but their structure appears to adapt them to receive and preserve a small electrical power. That the nerves arranged with muscles, so as to form a voltaic battery, have a power of accumulating and communicating electricity, is proved by the well-known experiments on the frog.

There are several circumstances in the structure of the nerves, and their arrangements in animal bodies, which do not appear at all applicable to the purposes of common sensation, and whose uses have not even been devised. The organs of secretion are principally made up of arteries and veins; but there is nothing in the different modes in which these vessels ramify, that can in any way account for the changes in the blood, out of which the secretions arise. These organs are also abundantly supplied with nerves.

By experiments, it was ascertained, that a low negative power of electricity separates from the serum of the blood an alkaline solution of albumen; that a low positive power separates albumen with acid, and the salts of the blood; that with one degree of power, albumen is separated in a solid

form —with a less degree, it is separated in a fluid form. From these facts the following queries are proposed: 1. That such a decomposition of the blood, by electricity, may be as near an approach to secretion as could be expected to be produced by artificial means, at present in our power. 2. That a weaker power of electricity than any that can be kept up by art, may be capable of separating from the blood the different parts of which it is composed, and forming new combinations of the parts so separated. 3. That the structure of the nerves may fit them to have a low electrical power; and as low powers are not influenced by imperfect conductors, as animal fluids, the nerves will not be robbed of their electricity by the surrounding parts. "4. That the discovery of an electrical power which can separate albumen from the blood in a fluid state, and another that separates it in a solid state, may explain the mode in which different animal solids and fluids may be produced, since albumen is the principal material of which animal bodies are composed. 5. That the nerves of the torpedo may not only keep the electric organ under the command of the will, but charge the battery, by secreting the fluid between the plates, that is necessary for its activity. 6. As albumen becomes coagulated by the effect of a power too low to affect the most delicate electrometer, may it not occasionally be employed as a chemical test of electricity, while the production of acid and alkali, affected by still inferior degrees of electricity to those required for the coagulation of albumen, may likewise be regarded as auxiliary tests on such occasions."

On the Duration of Voluntary Action; on the Origin of Sea Sickness; and on the Advantage derived from riding, and other Modes of Gestation, in assisting the Health under various Circumstances. By Dr. WOLLASTON.

IN speaking of the duration of muscular power, he observes, that each effort, though apparently single, consists in reality of a number of contractions repeated at extremely short intervals, so short that the intermediate relaxations cannot be visible, unless prolonged beyond the usual limits by a state of partial or general debility. The existence of these alternate motions he infers from a sensation perceptible upon inserting the extremity of the finger into the ear, because a sound is then perceived which resembles that of carriages at a distance passing rapidly over a pavement, and their frequency he estimates at twenty or thirty in a second.

The doctor was led to the investigation of the cause of sea-sickness from what he himself experienced in a voyage. He first observed a peculiarity in his mode of respiration, evidently connected with the motion of the vessel. The principal uneasiness is felt during the subsidence of the vessel by the sinking of the wave on which it rests. It is during this subsidence that the blood has a tendency to press with unusual force upon the brain. This fact is elucidated by reasoning, and by what is known to occur in the barometer, which, when carried out to sea in a calm, rests at the same height at which it would stand on the shore; but when the ship falls by the subsidence of the wave, the mercury is seen apparently to rise in the tube that contains it, because a portion of its gravity is then employed in occasioning its descent along with the vessel; and accordingly, if it were confined in a tube closed at bottom, it would no longer press with its whole weight upon the lower end. In the same manner, and for the same reason, the blood no longer presses downwards with its whole weight, and will be driven upwards by the elasticity which before was merely sufficient to support it. The sickness occasioned by swinging may be explained in the same way. It is in descending forwards that this sensation is perceived, for then the blood has the greatest tendency to move from the feet towards the head, since the line joining them is in the direction of the motion; but when the descent is backwards, and the motion is transverse to the line of the body, it occasions little inconvenience because the tendency to propel the blood towards the head is inconsiderable. Dr. Wollaston thinks that the contents of the intestines are also affected by the same cause as the blood: and if these have any direct disposition to regurgitate, this consequence will be in no degree counteracted by the process of respiration. "In thus referring," says our author, "the sensations of sea-sickness in so great a degree to the agency of mere mechanical pressure, I feel confirmed, by considering the consequence of an opposite motion, which, by too quickly withdrawing blood from the head, occasions a tendency to faint, or that approach to fainting which amounts to a momentary giddiness with a diminution of muscular power.

His explanation of the effects of external motion upon the circulation of the blood is founded upon a part of the structure observable in the venous system. The valves allow a free passage to the blood, when propelled forwards by any motion that assists its progress; but they oppose an immediate obstacle to such as have a contrary tendency. The circulation

is consequently helped forward by every degree of gentle agitation. The heart is supported in any laborious effort; it is assisted in the great work of restoring a system, which has recently struggled with some violent attack; or it is allowed as it were to rest from a labour to which it is unequal, when the powers of life are nearly exhausted by any lingering disorder. In the relief thus afforded to an organ so essential to life, all other vital functions must necessarily participate, and the offices of secretion and assimilation will be promoted during such comparative repose from laborious exertion.

On the Old Age and Decay of Trees. By Mr. Knight

The roots of trees, particularly those in coppices which are felled at stated periods, continue so long to produce and feed a succession of branches, that no experiments were required to prove, that it is not any defective action of the root which occasions the debility and diseases of old varieties of the apple and pear-tree. Having formerly adduced arguments, which are uncontradicted, to show that the sap of plants circulates through their leaves as the blood of animals circulates through their lungs; and having also shown that grafted trees of old and debilitated varieties of fruit became most diseased in rich soils, and when grafted on stocks of the most vigorous growth, which led him to suspect that in such cases more food is collected and carried up into the plant than its leaves can prepare and assimilate; and the matter thus collected, which would have promoted the health and growth in a vigorous variety, accumulates and generates disease in the extremities of the branches and annual shoots, while the lower part of the trunk and roots remain generally free from any apparent disease;—he hence attributes the diseases and debility of old age in trees to an inability to produce leaves which can efficiently execute their natural office, and to some consequent imperfection in the circulating fluid. It is said, that the leaves are annually reproduced, and are therefore annually new; but there seems to be an essential difference between the new leaves of an old and of a young variety; and it is certain, that the external character of the leaf of the same variety at two, and at twenty, years old, is very dissimilar; and therefore to Mr. Knight it appears not improbable, that further changes will have taken place at the end of two centuries. "If," says he, "these opinions be well founded, and the leaves of trees be analogous to the lungs of animals, is it improbable that the

natural debility of old age of trees and of animals may originate from a similar source?"

Observations upon luminous Animals. By Mr. Macartney.

The zoophite is the most splendid of the luminous inhabitants of the ocean. The flashes of light emitted during its contractions are so vivid as to affect the sight of the spectator. The luminous state of the sea between the tropics is generally accompanied with the appearance of a great number of marine animals, of various kinds, upon the surface of the water. In the Arabian Sea have been seen several luminous spots in the water, and when the animals, supposed to be the cause of them, were examined, they were found to be insects about the third of an inch in length, resembling in appearance the wood-louse. The insect, when viewed with the microscope, seemed to be formed by sections of a thin crustaceous substance. During the time that any fluid remained in the animal, it shone brilliantly like the fire-fly.

He notices many others that have from time to time come under his inspection: one of these, which he denominates the beroe fulgens, is a very elegant creature, changing its colour between purple, violet, and pale blue: the body is truncated before and pointed behind; but the exact form is difficult to assign, as it is varied by particular contractions at the animal's pleasure. When this insect swam gently near the surface of the water, its whole body became occasionally illuminated in a slight degree: during its contractions a stronger light issued from the ribs, and when a sudden shock was communicated to the water, in which several of these animals were placed, a vivid flash was thrown out. If the body were broken, the fragments continued luminous for several seconds, and being rubbed on the hand, left a light like that of phosphorus; this, however, as well as every other mode of emitting light, ceased after the death of the animal. Mr. Macartney, having noticed many other species, says, that his own observations lead him to conclude, that the medusa scintillans is the most frequent source of light of the sea round this country, and likewise in other parts of the world.

We are next informed, that the remarkable property of emitting light during life, is only met with among animals of the four last classes of modern naturalists, viz. mollusca, insects, worms, and zoophytes. The mollusca and worms contain each but a single species: the pholas dactylus in the one, and nereis noctiluca in the other. Some species yield light in the

eight following genera of insects, viz. elater, lampyris, fulgora, paussus, scolopendra, cancer, lynceus, and limulus. The luminous species of the genera lampyris and fulgora are more numerous than is generally supposed. Among the zoophytes, the genera medusa, beroe, and pennatula, contain species which afford light. The only animals that appear to possess a distinct organization for the production of light, are the luminous species of lampyris, elater, fulgora, and paussus.

The light of the lampyrides proceeds from some of the last rings of the abdomen, which, when not illuminated, are of a yellow colour. The number of luminous rings varies in different species, and, as it seems, at different periods in the same individual. Besides this luminous substance there are, in the common glow-worm, on the inner side of the last abdominal ring, two bodies, which to the naked eye appear more minute than the head of the smallest pin. They are lodged in two slight depressions, formed in the shell of the ring, which is at these points particularly transparent. These, when examined, were found to be sacs, and contain a soft yellow substance. The light that proceeds from these sacs is less under the control of the insect than that of the luminous substance spread on the rings: it is seldom entirely extinguished in the season that the glow-worm gives light, even during the day; and when all the other rings are dark these sacs often shine brightly. In all the dissections made by Mr. Marcartney of luminous insects, he did not find that the organs of light were better, or differently supplied with either nerves or air-tubes, than other parts of the body. The power of emitting light likewise exists in some creatures which want nerves; a circumstance that strongly marks the difference between animal light and animal electricity. In general, the exhibition of light, in animals, depends upon the presence of a fluid matter, which in some instances is confined to particular parts of the body, and in others is diffused throughout the whole substance of the animal.

The property of emitting light is confined to animals of the simplest organization, the greater number of which are inhabitants of the sea. The luminous property is not constant, but in general exists only in certain periods in particular states of the animal body. The power of showing light resides in a particular substance, or fluid, which is sometimes situated in a particular organ, and in others diffused throughout the animal's body. The light is differently regulated when the luminous matter exists in the living body, and when it is abstracted from it. In the first case it is intermitting

with periods of darkness, is commonly produced or increased by a muscular effort, and is sometimes absolutely dependent upon the will of the animal. In the second case, the luminous appearance is usually permanent, until it becomes extinct; after which it may be restored directly by friction, concussion, and the application of warmth, which last causes operate on the luminous matter only indirectly by exciting the animal.

The luminous matter, in all situations, is incombustible, and loses the quality of emitting light by being dried, or much heated. The exhibition of light, however long it may be continued, causes no diminution of the bulk of the luminous matter. It does not require the presence of pure air, and is not extinguished by other gases. The luminous appearance of living animals is not exhausted by long continuance, or frequent repetitions, nor accumulated by exposure to natural light: it is therefore not dependent upon any foreign source, but inheres as a property, in a peculiarly organized animal substance, or fluid, and is regulated by the same laws which govern all other functions of living beings. The light of the sea is always produced by living animals, and most frequently by the presence of the medusa scintillans. When great numbers of this species approach the surface, they sometimes coalesce, and cause that snowy or milky appearance of the sea, which is so alarming to navigators. These animals, when congregated on the surface of the water, can produce a flash of light like an electric corruscation. The luminous property does not appear to have any connection with the economy of the animals that possess it, except in flying insects, which by that means discover each other at night, for the purpose of sexual congress.

Account of a Vegetable Wax from Brazil. By W. T. Brande.

The vegetable wax described in this paper is said to be the production of a tree of slow growth, called by the natives *Carnauba*, which produces a gum used as food for man, and another substance employed for fattening poultry. If this article can be procured in abundance, it may become a valuable addition to the comforts of mankind, by reducing the price and improving the quality of candles, flambeaux, &c.

The wax, in its rough state, is in the form of a coarse grey powder, soft to the touch, and mixed with various impurities, which, when separated by a sieve, amount to about 40 per

cent. It has an agreeable odour, somewhat resembling new hay, but scarcely any taste.

At 206 of Fahr. it enters into perfect fusion, and may then be further purified by passing it through fine linen: it then acquires a dirty-green colour, and its peculiar smell becomes more evident. When cold, it is moderately hard and brittle: its specific gravity is 980.

Although the vegetable wax possesses the characteristic properties of bees'-wax, it differs from that substance in many of its chemical habitudes. It also differs from the other varieties of wax; namely, the wax of the myrica cerifera, of lac, and of white lac.

Perhaps the most important part of the present enquiry is that which relates to the combustion of this wax in the form of candles. The trials which have been made to ascertain its fitness for this purpose are very satisfactory. The addition, it appears, of from one-eighth to one-tenth part of tallow is sufficient to obviate the brittleness of the wax in its pure state, without producing any unpleasant effect."

Narrative of the Eruption of a Volcano in the Sea off the Island of St. Michael. By S. Tillard, Esq. Captain in the Royal Navy.

Approaching the island of St. Michael, on Sunday the 12th of June, 1811, in his Majesty's sloop Sabrina, under my command, we occasionally observed, rising in the horizon, two or three columns of smoke, such as would have been occasioned by an action between two ships, to which cause we universally attributed its origin. This opinion was, however, in a very short time changed, from the smoke increasing and ascending in much larger bodies than could possibly have been produced by such an event; and having heard an account, prior to our sailing from Lisbon, that in the preceding January or February a volcano had burst out within the sea near St. Michael's, we immediately concluded that the smoke we saw proceeded from that cause, and, on our anchoring the next morning in the road of Ponta del Gada, we found this conjecture correct as to the cause, but not to the time; the eruption of January having totally subsided, and the present one having only burst forth two days prior to our approach, and about three miles distant from the one before alluded to.

Desirous of examining as minutely as possible a contention so extraordinary between two such powerful elements, I set

off from the city of Ponta del Gada on the morning of the 14th, in company with Mr. Read, the consul general of the Azores, and two other gentlemen. After riding about twenty miles across the N.W. end of the island of St. Michael's, we came to the edge of a cliff, from whence the volcano burst suddenly upon our view in the most terrific and awful grandeur. It was only a short mile from the base of the cliff, which was nearly perpendicular, and formed the margin of the sea; this cliff being, as nearly as I could judge, from three to four hundred feet high. To give you an adequate idea of the scene by description is far beyond my powers; but for your satisfaction I shall attempt it.

Imagine an immense body of smoke rising from the sea, the surface of which was marked by the silvery rippling of the waves, occasioned by the light and steady breezes incidental to those climates in summer. In a quiescent state, it had the appearance of a circular cloud revolving on the water like an horizontal wheel, in various and irregular involutions, expanding itself gradually on the lee side, when suddenly a column of the blackest cinders, ashes, and stones, would shoot up in form of a spire at an angle of from ten to twenty degrees from a perpendicular line, the angle of inclination being universally to windward; this was rapidly succeeded by a second, third, and fourth, each acquiring greater velocity, and overtopping the other, till they had attained an altitude as much above the level of our eye, as the sea was below it.

As the impetus with which the columns were severally propelled diminished, and their ascending motion had nearly ceased, they broke into various branches resembling a group of pines; these again, forming themselves into festoons of white feathery smoke in the most fanciful manner imaginable, intermixed with the finest particles of falling ashes, which at one time assumed the appearance of innumerable plumes of black and white ostrich feathers surmounting each other; at another, that of the light wavy branches of a weeping willow.

During these bursts, the most vivid flashes of lightning continually issued from the densest part of the volcano; and the cloud of smoke, now ascending to an altitude much above the highest point to which the ashes were projected, rolled off in large masses of fleecy clouds, gradually expanding themselves before the wind in a direction nearly horizontal, and drawing up to them a quantity of water-spouts, which formed a most beautiful and striking addition to the general appearance of the scene.

That part of the sea where the volcano was situated was upwards of thirty fathoms deep, and at the time of our viewing it the volcano was only four days old. Soon after our arrival on the cliff, a peasant observed he could discern a peak above the water; we looked, but could not see it: however, in less than half an hour it was plainly visible, and before we quitted the place, which was about three hours from the time of our arrival, a complete crater was formed above the water, not less than twenty feet high on the side where the greatest quantity of ashes fell; the diameter of the crater being apparently about four or five hundred feet.

The great eruptions were generally attended with a noise like the continued firing of cannon and musquetry intermixed, as also with slight shocks of earthquakes, several of which having been felt by my companions, but none by myself, I had become half sceptical, and thought their opinion arose merely from the force of imagination; but while we were sitting within five or six yards of the edge of the cliff, partaking of a slight repast which had been brought with us, and were all busily engaged, one of the most magnificent bursts took place which we had yet witnessed, accompanied by a very severe shock of an earthquake. The instantaneous and involuntary movement of each was to spring upon his feet, and I said, "This admits of no doubt." The words had scarce passed my lips, before we observed a large portion of the face of the cliff, about fifty yards on our left, falling, which it did with a violent crash. So soon as our first consternation had a little subsided, we removed about ten or a dozen yards further from the edge of the cliff, and finished our dinner.

On the succeeding day, June 15th, having the Consul and some other friends on board, I weighed and proceeded with the ship towards the volcano, with the intention of witnessing a night view; but in this expectation we were greatly disappointed, from the wind freshening and the weather becoming thick and hazy, and also from the volcano itself being clearly more quiescent than it was the preceding day.

On opening the volcano clear of the N.W. part of the island, after dark on the 16th, we witnessed one or two eruptions that, had the ship been near enough, would have been awfully grand. It appeared one continued blaze of lightning; but the distance which it was at from the ship (upwards of twenty miles) prevented our seeing it with effect. Returning again towards St. Michael's, on the fourth of July, I was obliged, by the state of the wind, to pass with the ship very close to the island, which was now completely formed

by the volcano, being nearly the height of Matlock High Tor, about eighty yards above the sea. At this time it was perfectly tranquil; which circumstance determined me to land, and explore it more narrowly. "I left the ship in one of the boats, accompanied by some of the officers. As we approached, we perceived that it was still smoking in many parts, and, upon our reaching the island, found the surf on the beach very high. Rowing round to the lee side, with some little difficulty, by the aid of an oar, as a pole, I jumped on shore, and was followed by the other officers. We found a narrow beach of black ashes, from which the side of the island rose in general too steep to admit of our ascending; and, where we could have clambered up, the mass of matter was much too hot to allow our proceeding more than a few yards in the ascent.

The declivity below the surface of the sea was equally steep, having seven fathoms water scarce the boat's length from the shore, and at the distance of twenty or thirty yards we sounded twenty-five fathoms From walking round it in about twelve minutes, I should judge that it was something less than a mile in circumference; but the most extraordinary part was the crater, the mouth of which, on the side facing St Michael's, was nearly level with the sea. It was filled with water, at that time boiling, and was emptying itself into the sea by a small stream about six yards over, and by which I should suppose it was continually filled again at high water. This stream, close to the edge of the sea, was so hot, as only to admit the finger to be dipped suddenly in, and taken out again immediately.

It appeared evident, by the formation of this part of the island, that the sea had, during the eruptions, broke into the crater in two places, as the east side of the small stream was bounded by a precipice, a cliff between twenty and thirty feet high forming a peninsula of about the same dimensions in width, and from fifty to sixty feet long, connected with the other part of the island by a narrow ridge of cinders and lava, as an isthmus of from forty to fifty feet in length, from which the crater rose in the form of an amphitheatre.

This cliff, at two or three miles distance from the island, had the appearance of a work of art, resembling a small fort or block-house. The top of this we were determined, if possible, to attain; but the difficulty we had to encounter in doing so was considerable: the only way to attempt it was up the side of the isthmus, which was so steep, that the only mode by which we could effect it, was by fixing the end of

an oar at the base, with the assistance of which we forced ourselves up in nearly a backward direction.

Having reached the summit of the isthmus, we found another difficulty, for it was impossible to walk upon it, as the descent on the other side was immediate, and as steep as the one we had ascended; but, by throwing our legs across it, as would be done on the ridge of a house, and moving ourselves forward by our hands, we at length reached that part of it where it gradually widened itself and formed the summit of the cliff, which we found to have a perfectly flat surface, of the dimensions before stated. Judging this to be the most conspicuous situation, we here planted the Union, and left a bottle sealed up containing a small account of the origin of the island, and of our having landed upon it, and naming it Sabrina Island.

Within the crater I found the complete skeleton of a guard fish, the bones of which, being perfectly burnt, fell to pieces upon attempting to take them up; and, by the account of the inhabitants on the coast of St. Michael's, great numbers of fish had been destroyed during the early part of the eruption, as large quantities, probably suffocated or poisoned, were occasionally found drifted into the small inlets or bays. The island, like other volcanic productions, is composed principally of porous substances, and generally burnt to complete cinders, with occasional masses of a stone, which I should suppose to be a mixture of iron and lime-stone.

Experiments on Poisons of the Mineral Kingdom. By Mr. BRODIE.

Experiments with the Woorara.—IN an experiment, I succeeded in recovering an animal, which was apparently dead from the influence of the essential oil of bitter almonds, by continuing respiration artificially until the impression of the poison upon the brain had ceased; but a similar experiment on an animal under the influence of the woorara was not attended with the same success.

On the Effects of Arsenic.— When an animal is killed by arsenic taken internally, the stomach is found bearing marks of inflammation.

But in whatever way the poison is administered, the inflammation is confined to the stomach and intestines; I have never seen any appearance of it in the pharynx or œsophagus. The symptoms produced by arsenic may be referred to the influence of the poison on the nervous system, the heart, and

the alimentary canal. As of these the two former only are concerned in those functions which are directly necessary to life, and as the alimentary canal is often affected only in a slight degree, we must consider the affection of the heart and nervous system as being the immediate cause of death.

In every experiment which I have made with arsenic, there were evident marks of the influence of the poison on all the organs which have been mentioned; but they were not in all cases affected in the same relative degree. In the dog, the affection of the heart appeared to predominate over that of the brain; and on examining the thorax immediately after death, this organ was found to have ceased acting, and in a distended state. In the rabbit, the affection of the brain appeared to predominate over that of the heart, and the latter was usually found acting slowly and feebly, after the functions of the brain had entirely ceased. In the rabbit, the effects of the arsenic on the stomach and intestines were usually less than in carnivorous animals.

The action of arsenic on the system is less simple than that of the majority of vegetable poisons. As it acts on different organs, it occasions different orders of symptoms; and as the affection of one or another organ predominates, so there is some variety in the symptoms produced even in individual animals of the same species

In animals killed by arsenic, the blood is usually found fluid in the heart and vessels after death; but, otherwise, all the morbid appearances met with on dissection are confined to the stomach and intestines.

Experiments with the Muriate of Barytes. — When barytes is taken into the stomach, or applied to a wound, it is capable of destroying life; but, when in its uncombined state, its action is very slow. The muriate of barytes, which is much more soluble than the pure earth, is (probably on this account) a much more active poison.

On the Effects of the Emetic Tartar. — The effects of the emetic tartar so much resemble those of arsenic and of muriate of barytes in essential circumstances, that it would be needless to enter into a detail of the individual experiments made with this poison.

On the Effects of the Corrosive Sublimate. — When this poison is taken internally in very small and repeated doses, it is absorbed into the circulation, and produces on the system those peculiar effects which are produced by other preparations of mercury. If it passes into the circulation in larger quantity, it excites inflammation of some part of the alimen-

tary canal, the termination of which may vary accordingly as it exists in a greater or less degree. When taken in a larger quantity still, it occasions death in a very short space of time. I had found, that, if applied to a wounded surface, it produced a slough of the part to which it was applied, without occasioning any affection of the general system. This led me to conclude, that the effects of it, taken internally and in a large quantity, depended on its local action on the stomach, and were not connected with the absorption of it into the circulation.

That a sudden and violent injury of the stomach should be capable of thus speedily proving fatal, is not surprising, when we consider the powerful sympathy between it and the organs on which life more immediately depends, and the existence of which many circumstances in disease daily demonstrate to us.

The facts which have been stated, appear to lead to the following conclusions respecting the action of the mineral poisons which were employed in the foregoing experiments: —

1. Arsenic, the emetic tartar, and the muriate of barytes, do not produce their deleterious effects until they have passed into the circulation.

2. All of these poisons occasion disorder of the functions of the heart, brain, and alimentary canal; but they do not all affect these organs in the same relative degree.

3. Arsenic operates on the alimentary canal in a greater degree than either the emetic tartar or the muriate of barytes. The heart is affected more by arsenic than by the emetic tartar, and more by this last than by the muriate of barytes.

4. The corrosive sublimate, when taken internally in large quantity, occasions death by acting chemically on the mucous membrane of the stomach, so as to destroy its texture; the organs more immediately necessary to life being affected in consequence of their sympathy with the stomach.

In making the comparison between them, we observe that the effects of mineral are less simple than those of the generality of vegetable poisons; and, when once an animal is affected by the former, there is much less chance of his recovery than when he is affected by the latter.

On the Motions of the Tendrils of Plants. By THOMAS ANDREW KNIGHT, *Esq. F.R.S.*

THE motions of the tendrils of plants, and the efforts they apparently make to approach and attach themselves to contiguous objects, have been supposed by many naturalists to originate in some degrees of sensation and perception; and though other naturalists have rejected this hypothesis, few or no experiments have been made by them to ascertain with what propriety the various motions of tendrils of different kinds can be attributed to peculiarity of organisation, and the operation of external causes.

The plants selected were the Virginia creeper (the ampelopsis quinquefolia of Michaux), the ivy, and the common vine and pea.

A plant of the ampelopsis, which grew in a garden pot, was removed to a forcing house in the end of May, and a single shoot from it was made to grow perpendicularly upwards, by being supported in that position by a very slender bar of wood, to which it was bound. The plant was placed in the middle of the house, and was fully exposed to the sun; and every object around it was removed far beyond the reach of its tendrils. Thus circumstanced, its tendrils, as soon as they were nearly full grown, all pointed towards the north, or back wall, which was distant about eight feet; but, not meeting with any thing in that direction to which they could attach themselves, they declined gradually towards the ground, and ultimately attached themselves to the stem beneath, and the slender bar of wood.

A plant of the same species was placed at the east end of the house, near the glass, and was in some measure skreened from the perpendicular light; when its tendrils pointed towards the west, or centre of the house, as those under the preceding circumstances had pointed towards the north and back wall. This plant was removed to the west end of the house, and exposed to the evening sun, being skreened, as in the preceding case, from the perpendicular light; and its tendrils, within a few hours, changed their direction, and again pointed to the centre of the house, which was partially covered with vines. This plant was then removed to the centre of the house, and fully exposed to the perpendicular light, and to the sun; and a piece of dark-coloured paper was placed upon one side of it, just within reach of its tendrils; and to this substance they soon appeared to be strongly attracted. The paper was then placed upon the opposite side,

under similar circumstances, and there it was soon followed by the tendrils. It was then removed, and a piece of plate glass was substituted; but to this substance the tendrils did not indicate any disposition to approach. The position of the glass was then changed, and care was taken to adjust its surface to the varying position of the sun, so that the light reflected might continue to strike the tendrils, which then receded from the glass, and appeared to be strongly repulsed by it.

The claws or claspers of the ivy, to experiments upon which I shall now proceed, appear to be cortical protrusions only; but are capable (I have reason to believe) of becoming perfect roots, under favourable circumstances. Experiments, in every respect nearly similar to the preceding, were made upon this plant; but I found it necessary to place the different substances, to which I proposed that the claws should attempt to attach themselves, almost in contact with the stems of the plants. I observed that the claws of this plant evaded the light, just as the tendrils of the ampelopsis had done; and that they sprang only from such parts of the stems as were fully or partially shaded.

It appears, therefore, that not only the tendrils and claws of these creeping dependent plants, but that their stems also, are made to recede from light, and to press against the opaque bodies which nature intended to support and protect them.

A third set of plants were trained almost perpendicularly downwards, but with an inclination of a few degrees towards the north: and the tendrils of these permanently retained very nearly their first position, relatively to their stems; whence it appears that these organs, like the tendrils of the ampelopsis, and the claws of the ivy, are to a great extent under the control of light.

A few other plants of the same species were trained in each of the preceding methods; but proper objects were placed in different situations near them, with which their tendrils might come into contact; and I was by these means afforded an opportunity of observing with accuracy the difference between the motions of these and those of the ampelopsis, under similar circumstances. The latter almost immediately receded from light, by whatever means that was made to operate upon them; and they did not subsequently show any disposition to approach the points from which they once receded. The tendrils of the vine, on the contrary, varied their positions in every period of the day, and after returned again during the night to the situations they had occupied

in the preceding morning; and they did not so immediately, or so regularly, bend towards the shade of contiguous objects.

The tendril of the vine, in its internal organisation, is apparently similar to the young succulent shoot, and leaf-stalk, of the same plant; and it is as abundantly provided with vessels, or passages, for the sap; and I have proved that it is alike capable of feeding a succulent shoot, or a leaf, when grafted upon it. It appears, therefore, I conceive, not improbable, that a considerable quantity of the moving fluid of the plant passes through its tendrils; and that there is a close connection between its vascular structure and its motions.

The actions of the tendrils of the pea were so perfectly similar to those of the vine, when they came into contact with any body, that I need not relate the observations I made upon that plant. An increased extension of the cellular substance of the bark upon one side of the tendrils, and a correspondent contraction upon the opposite side, occasioned by the operation of light, or the partial pressure of a body in contact, appeared, in every case which has come under my observation, the obvious cause of the motions of tendrils; and therefore I shall venture to infer, that they are the result of pure necessity only, uninfluenced by any degrees of sensation or intellectual power.

Observations relative to the Near and Distant Sight of different Persons. By James Ware, *Esq.*

This paper contains many cases of near-sighted persons, with some remarkable changes produced in the sight by different causes, authorising the following conclusions:

1. That near-sightedness is rarely observed in infants, or even in children under ten years of age. It affects the higher classes of society more than the lower: and the instances are few, if any, in which, if the use of concave glasses has been adopted, increasing years have either removed or lessened this imperfection.

2. That though the usual effect of time on perfect eyes be that of inducing a necessity to make use of convex glasses, in order to see near objects distinctly; yet sometimes, even after the age of fifty, and after convex glasses have been used many years for this purpose, the eyes have not only ceased to derive benefit from them, when looking at near objects, but they have required concave glasses to enable them to distinguish with precision objects at a distance.

3. That though the cause of this change be not always known, yet sometimes it has been induced by the use of evacuating remedies, particularly of leeches applied to the temples; and sometimes by looking through a microscope, for a continued length of time, for several successive days.

4. That instances are not uncommon in which persons far advanced in life (viz. between eighty and ninety), whose eyes have been accustomed for a long time to the use of deeply convex glasses, when they have read or written, have ceased to derive benefit from these glasses, and they have become able, without any assistance, to see both near and distant objects almost as well as when they were young. Although it be not easy to ascertain the cause of this amended vision, it seems not improbable that it is occasioned by an absorption of part of the vitreous humour; in consequence of which the sides of the eye collapse, and its axis from the cornea to the retina is lengthened; by which alteration the length of this axis is brought into the same proportion to the flattened state of the cornea, or crystalline, or both, which it had to these parts before the alteration took place.

An Account of some Organic Remains found near Brentford, Middlesex; in a Letter to Sir Joseph Banks. By Mr. J. R TRIMMER.

THE specimens have been collected from two fields, not contiguous to each other; therefore, to avoid confusion, I shall take each field separately, first describing the strata as far as they have come within my knowledge, and afterwards I shall speak of the organic remains as they were respectively found in those strata.

The first field is about half a mile north of the Thames at Kew bridge; its surface is about twenty-five feet above the Thames at low water. The strata here are first, sandy loam from six to seven feet, the lowest two feet slightly calcareous. Second, sandy gravel a few inches only in thickness. Third. loam slightly calcareous from one to five feet; between this and the next stratum peat frequently intervenes in small patches of only a few yards wide and a few inches thick. Fourth, gravel containing water; this stratum varies from two to ten feet in thickness, and is always the deepest in the places covered by peat; in these places the lower part of the stratum becomes an heterogeneous mass of clay, sand, and gravel, and frequently exhales a disagreeable muddy smell. Fifth, the main stratum of blue clay, which lies under this,

and extends under London and its vicinity. The average depth of this clay has been ascertained, by wells that have been dug through it, to be about two hundred feet under the surface of the more level lands, and proportionably deeper under the hills, as appears from Lord Spencer's well at Wimbledon, which is five hundred and sixty-seven feet deep. This stratum, besides figured fossils, contains pyrites and many detached nodules; at the depth of twenty feet there is a regular stratum of these nodules, some of which are of very considerable size.

In the first stratum, as far as my observation has extended, no remains of an organised body have ever been found, and as my search has not been very limited, I may venture to say it contains none. In the second stratum, snail shells, and the shells of river fish have been found, and a few bones of land animals; but of inconsiderable size, and in such a mutilated state, that it cannot be ascertained to what class they belong. In the third stratum, the horns and bones of the ox, and the horns, bones, and teeth of the deer have been found, and also, as in the second stratum, snail shells, and the shells of river fish. In the fourth stratum were found teeth and bones of both the African and Asiatic elephant, teeth of the hippopotamus; bones, horns, and teeth of the ox.

In the fifth stratum, namely the blue clay, the extraneous fossils are entirely marine, with the exception of some specimens of fruit and pieces of petrified wood, the latter of which may be considered as marine, because, when of sufficient size, they are always penetrated by teredines. The other fossils from this stratum are nautili, oysters, pinnæ marinæ, crabs, teeth and bones of fish, and a great variety of small marine shells; this stratum has been penetrated hitherto in this field only to the depth of thirty feet, throughout which the specimens found were dispersed without any regularity.

The second field is about one mile to the westward of the former, one mile north of the Thames, and a quarter of a mile to the eastward of the river Brent; its height above the Thames, at low water, is about forty feet.

In the first stratum, as in the other field, no organic remains have been observed. In the second, but always within two feet of the third stratum, have been found the teeth and bones of the hippopotamus; the teeth and bones of the elephant; the horns, bones, and teeth of several species of deer; the horns, bones, and teeth of the ox; and the shells of river fish.

The remains of hippopotami are so extremely abundant, that in turning over an area of one hundred and twenty yards in the present season, parts of six tusks have been found of

this animal, besides a tooth and part of the horn of a deer; part of a tusk, and part of a grinder of an elephant; and the horns, with a small part of the skull, of an ox. One of these horns I had an opportunity of measuring, as it lay on the ground, and found it to be four feet and a half in length, following the curve, and five inches in diameter at the large end; it was found impracticable to remove it, otherwise than in fragments, which I have preserved, and have hopes of being able to put a considerable part of it together. The immense size of this horn is rendered more remarkable by another horn from the same spot, which measures but six inches in length.

In the third stratum, viz. calcareous loam, have been found the horns, bones, and teeth of the deer, the bones and teeth of the ox, together with snail shells and the shells of river fish.

On a fossil Human Skeleton, found at Guadaloupe. By Mr. Kœnig.

This singular fossil was found on the shores of Guadaloupe, below high-water mark, among calcareous rocks, formed of madrepores, &c. and not very remote from the volcano, called the Souffriere The block containing the human skeleton is eight feet long, two broad, and weighs about two tons: it is a very hard granular lime-stone, resembling calcareous sand-stone, containing a few venus and other shells, some of which are unknown. The skeleton is tolerably perfect, with the exception of the skull and some vertebræ of the neck, which are wanting. Sir H. Davy found some phosphate of lime in the bones, proving the presence of animal matter.

Mr. K. does not pretend to guess at the age of this fossil skeleton; but Sir Joseph Banks, whose experience and observation are more extensive, considers it of very modern formation. Other fossil bones have been found in the same vicinity, and calcareous masses, or rocks, are now being formed there. This circumstance seems to sanction the opinion of the learned president, taking into consideration also, the contiguity of a volcano, the probability of the temperature of the water being considerably raised at some times, and the known fact, that carbonate of lime, dissolved in water, is afterwards deposited in a comparatively short period, in masses of very hard and solid stone. Every person may be convinced of the rapidity of the formation, and also of the

hardness of each stone, by inspecting the inside of tea-kettles, in which water, vulgarly called hard, is boiled.

On the comparative Heat of arterial and venous Blood. By JOHN DAVY, M.D.

THE experiments of Crawford being performed at a time when the process and means of analysis were much less perfect than at present, it is necessary they should be repeated before they can be received as correct results in the actual state of our knowledge. Dr. Davy operated on the blood of sheep and lambs; and it must be confessed, that the detail of his experiments will be read with the more pleasure, that no animal experienced any pain from his researches.

He began by depriving arterial and venous blood of fibrine, ascertaining their specific gravity, the former being 1047, and the latter 1050, placing them in glasses of equal dimensions, filling a similar glass with water, raised to the same temperature, and observing their relative rate of cooling. In different experiments, he found arterial blood 93.7, and venous 92, a result altogether incompatible with the theory of Crawford, but reconcileable with that of Dr. Black, or the opinion of Mr. Brodie. The posterior portion of the brain he found from one to two degrees higher than the anterior, and both were as much lower than the rectum. The heat of the body generally diminishes in proportion to the distance from the heart.

In general, the temperature of arterial blood was from one to one and a half degree higher than that of venous; only one degree was observed between the heat of the blood in the left and right ventricle of the heart. A newly-born child raised the thermometer to 96; after three days it rose it to 99.

On the Structure of the starry Heavens. By Dr. HERSCHEL.

THE Doctor begins with relating his observations on the relative magnitudes of the stars, considering those of the first magnitude to be equal to our sun; he then determines the magnitudes and changes in the appearance of a great number of fixed stars; gives a history of the alterations which he has noticed in the aspect of the sidereal heavens during the last thirty years; and describes those stars which have increased in magnitude, or brilliancy; have lost or acquired surrounding nebulæ; or have had wings, tails, or other peculiarities.

He seems inclined to believe, from his observations, that new sidereal bodies are in a constant and progressive state of formation; that nebulous appearances gradually assume a globular character; that the heavens are not infinite; and that stars have a "compressing power."

He considers the origin and progress of sidereal bodies to be nearly in the following order: — First, vague and indistinct nebulæ like the milky way; secondly, detached or clustered nebulæ, which consolidate into clusters of stars; thirdly, these stars, becoming more definite, appear with nebulous appendages in the different forms of wings, tails, &c.; and lastly, that all are finally concentrated into one clear, bright, and large star.

Dr. H. concludes, that the progressive discovery of nebulæ will be equal to the improvement of our telescopes, and that in proportion as we are possessed of more powerful space-penetrating instruments, will our knowledge of the sidereal heavens be extended. Many of his latter observations, directed to ascertain the absorption or condensation of nebulæ, were made on stars which he had before described, others were made on those whose places have been determined by foreign astronomers.

On a new System of Ship Building. By Mr. Seppings.

Notwithstanding the rapid progress in all the arts and sciences, no improvement in naval architecture has taken place during many years. In order to make the simple, but great improvement, which Mr. S. has introduced, more intelligible, he begins by describing the old structure of ships, of their keel and ribs, or timbers placed at right angles, and the bottom and decks composed of parallel planks. According to the new construction, on which three ships have already been built, and four more are in progress, the timbers are crossed with diagonal girders, at angles of 45, so that the whole frame is rendered much stiffer or more inflexible, and all parts of the structure made to bear their due portion of the pressure at the same time. The first advantage of this plan, is the prevention of what is called *hogging*, or having the centre become convex on the upper, and concave on the lower side. Mr. S. fills up the space between the timbers with pieces of wood taken from old ships, made in the form of wedges, which are reversed, driven in tight, paid with tar, and made impervious to water; so that should an outer plank

start, the vessel will be in no danger of sinking, as in the old system. This method not only adds greatly to the stiffness and strength of the vessel, but also prevents the timbers and flooring from becoming a prey to the rot, occasioned by moisture and stagnant air. Mr. S. opposes the notion of ships being elastic, and contends that they are stronger and better in proportion as they are non-elastic, and capable of resisting pressure in whatever direction it may be applied. Considerable advantage he also considers must attend his plan, from the superior stiffness and strength of the decks, composed of frame-work with diagonal binders, so that the deck, instead of being a series of parallel boards, having very little connection with each other, and susceptible of being detached in any emergency, will present a continuous mass of timber, having its grain placed in all directions best adapted to make the greatest possible resistance to any external force. There are many other minor improvements in this new method, such as obviating the necessity of much iron work, so that no extra weight is occasioned by the filling-up between the timbers; less ballast is required; much old ship timber can be used with advantage; and lastly, in the construction of a 74 gun ship, 178 trees, of 50 feet each, are saved.

Experiments on the Vitality of Organised Matter. By ALEXANDER CRICHTON, *M. D.*

THE author having observed that organised bodies are influenced by laws very different from those of chemistry, that living matter overcomes affinity and gravity, and that whenever life ceases, the decomposition of organised bodies commences, seems thence to infer that there are two kinds of matter, or that organised matter still retains some latent vitality, notwithstanding its chemical decomposition. To ascertain this point, he made a variety of experiments on different vegetables, on dried barks, flowers, &c. using decoctions of vegetable matter, exposed to the action of oxygen and other gases in glass tubes over mercury, and in all of them, except a decoction of liquorice root, he discovered traces of vitality or fructification in a few days. The leaves of flowers he always found yielded the greatest quantities of organised or vitalic matter.

Astronomical Observations relating to the Sidereal Part of the Heavens, and its Connection with the Nebulous Part; arranged for the Purpose of a critical Examination. By WILLIAM HERSCHEL.

THE observations contained in this paper are intended to display the sidereal part of the heavens, and also to show the intimate connection between the two opposite extremes, one of which is the immensity of the widely diffused and seemingly chaotic nebulous matter; and the other the highly complicated and most artificially constructed globular clusters of compressed stars.

Of Stars in remarkable Situations with regard to Nebulæ.—Among the great number of stars, with nebulosity dispersed between them, are some in situations that deserve to be remarked.

A pretty bright star in the middle of a very bright nebula, about 10′ in length, and 2′ broad.

An extremely faint nebulosity extended from one star to a smaller one, at the distance of about 2′ south of the former.

Two considerable stars are involved in a very faint nebulosity of 3′ or 4′ in extent.

That stars are not spread in equal portions over the celestial regions, is evident to the eye of every one who directs his view to them in a clear night; but if this wanted any proof, the star-gauges would abundantly show that the greatest variety in their distribution takes place; for while in my sweeps, many fields of view of the telescope were without a single star, others contained every assignable number, from one to more than six hundred.

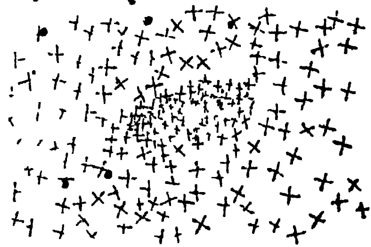
When clusters of stars are situated in very rich parts of the heavens, they are generally of an irregular form, and very imperfectly collected; those which are in and very near the milky way may indeed be looked upon as so many portions of the great mass drawn together by the action of a clustering power, of which they tend to prove the existence.

The stars of these clusters are in general very promiscuously scattered; they are, however, sufficiently drawn together to show that they form separate groups; and, in many places, a defalcation of the number of stars surrounding the clusters is already so far advanced as to indicate a tendency to future insulation.

The outlines of clusters of stars in rich parts of the heavens, and even of those that are insulated, are seldom suf-

ficiently defined to arrange such clusters by their figure; and, as the following assortment contains some that are variously extended and differently compressed, it will be seen, from the descriptions of a few of them, that the power which has drawn the stars together must have acted under different circumstances.

A very compressed cluster of small, and some large stars; extended nearly in the meridian; the most compressed part is about 8′ long and 2′ broad, with many stars scattered around it to a considerable distance.



The construction of this cluster may have arisen from the situation of many stars in the same plane, drawn towards a centre by the clustering power; for any plane seen obliquely will have the appearance of an extended form.

A large cluster of stars of a middling size, irregularly extended, and considerably rich. The stars are chiefly in rows.

Here each row of stars may have a different preponderating attraction, but every row will attract all the other rows; nay, from the laws of gravitation it is evident, that there must be somewhere, in all the rows together, the seat of a preponderating clustering power, which will act upon all the stars in the neighbourhood.

Of globular Clusters of Stars.—The objects of this collection are of a sufficient brightness to be seen with any good common telescope, in which they appear like telescopic comets, or bright nebulæ, and under this disguise we owe their discovery to many eminent astronomers, but in order to ascertain their most beautiful and artificial construction, the application of high powers, not only of penetrating into space, but also of magnifying, are absolutely necessary.

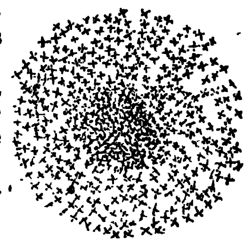
Oct. 4. 1810. 40-feet telescope. Space-penetrating power 191.68. Magnifying power 280. Having been a sufficient time at the telescope to prepare the eye properly for seeing

minute objects, the 72d of the *Connoissance des temps* came into the field. It is a very bright object.

It is a cluster of stars of a round figure, but the very faint stars on the outside of globular clusters are generally a little dispersed, so as to deviate from a perfect circular form. The telescopes which have the greatest light show this best.

It is very gradually extremely condensed in the centre; but with much attention, even there, the stars may be distinguished.

There are many stars in the field of view with it; but they are of several magnitudes, totally different from the extremely small ones which compose the cluster.



It is not possible to form an idea of the number of stars that may be in such a cluster; but, I think, we cannot estimate them by hundreds.

The diameter of the cluster is about one-fifth of the field, which gives 1′ 53″.6.

Of the breaking up of the Milky Way.—The milky way is generally represented in astronomical maps as an irregular zone of brightness, encircling the heavens, and my star-gauges have proved its whitish tinge to arise from accumulated stars, too faint to be distinguished by the eye. The great difficulty of giving a true picture of it is a sufficient excuse for those who have traced it on a globe, or through the different constellations of an Atlas Cœlestis, as if it were a uniform succession of brightness. It is, however, evident that, if ever it consisted of equally scattered stars, it does so no longer; for, by looking at it in a fine night, we may see its course between the constellations of Sagittarius and Persius, affected by not less than eighteen different shades of glimmering light, resembling the telescopic appearances of large easily resolvable nebulæ; but in addition to these general divisions, the observations detailed in the preceding part of this paper authorise us to anticipate the breaking up of the milky way, in all its minute parts, as the unavoidable consequence of the clustering power arising out of those preponderating attractions which have been shown to be every where existing in its compass.

157 instances have been given of clusters situated within the extent of the milky way. They may also be found in Bode's Atlas Cœlestis, whose delineation of this bright zone I have taken for a standard. To these must be added 68

more, which are in the less rich parts, or what may be called the varnishing borders of the milky way: for this immense stratum of stars does not break off abruptly, as generally represented in maps, but gradually becomes invisible to the eye when the stars are no longer sufficiently numerous to cause the impression of milkiness.

Now, since the stars of the milky way are permanently exposed to the action of a power whereby they are irresistibly drawn into groups, we may be certain that from mere clustering stars, they will be gradually compressed through successive stages of accumulation, more or less resembling the state of some of the 263 objects by which the operation of the clustering power has been laid open to our view, till they come up to what may be called the ripening period of the globular form, and total insulation; from which it is evident that the milky way must be finally broken up, and cease to be a stratum of scattered stars.

We may also draw a very important additional conclusion from the gradual dissolution of the milky way; for the state into which the incessant action of the clustering power has brought it at present, is a kind of chronometer that may be used to measure the time of its past and future existence; and although we do not know the rate of going of this mysterious chronometer, it is nevertheless certain, that, since the breaking up of the parts of the milky way affords a proof that it cannot last for ever, it equally bears witness that its past duration cannot be admitted to be infinite.

On some new Electro-chemical Phenomena. By William Thomas Brande, Esq.

When compound bodies, capable of transmitting electricity, are submitted to the operation of the Voltaic pile, their proximate and ultimate elements are separated with uniform phenomena; *acids* are attracted towards the positively electrified surface, and *alkaline* and *inflammable* substances take an opposite direction, and collect at the negative pole.

Of the *ultimate* chemical elements of bodies, the greater number exhibit the last-mentioned character, and a few only appear to be attracted towards the positive extremity of the Voltaic instrument; and as bodies possessed of dissimilar electrical powers attract each other, it has been concluded that the inherent electrical state of the former is positive, that of the latter negative.

When the flame of a candle is placed between two surfaces

in opposite electrical states, the negative surface becomes most heated; this circumstance was considered by Mr. Cuthbertson as indicating the passage of electrical fluid from the positive to the negative surface.

The insulated flames of wax, of oil, of spirit of wine, and of hydrogen gas, only conduct positive electricity; dry soap, on the contrary, and the flame of phosphorus, under the same circumstances, only transmit negative electricity.

I repeated Cuthbertson's experiment, and found that, when the electrical machine was in weak action, the negative surface not only became hot sooner than the positive, but that the smoke and flame of the candle were visibly attracted towards it. I now removed the candle, and substituted the flame of phosphorus, when the appearances were exactly reversed: the positive surface now became considerably warmer than the negative, and the flame and smoke of the phosphorus were powerfully directed upon it. I conceived, therefore, that the flame of the candle was attracted by the negative pole, in consequence of the carbon and hydrogen with which it abounds, and that the rapid formation of acid matter during the combustion of the phosphorus, was the cause of its attraction towards the positive pole: in short, that the appearances were consistent with the known laws of electro-chemical attraction.

The attraction of acids by the positively electrified surface, and of alkalies and inflammables by that which is negatively electrified, is thus easily exhibited; and the theory which regards their mutual attractive energies, as dependent upon their opposite electrical states, is confirmed by experiments, not less decisive than those in which the Voltaic instrument was employed.

Of the former class, phosphorus in slow and in rapid combustion, and benzoic acid, furnish the most striking instances; and of the latter, the combustion of potassium and camphor are excellent examples.

Some Experiments on the Combustion of the Diamond and other Carbonaceous Substances. By Sir Humphrey Davy.

In the very first trials on the combustion of the diamond, I ascertained a circumstance that I believe has not been noticed before; viz. that the diamond, when strongly ignited by the lens in a thin capsule of platinum, perforated with many orifices, so as to admit a free circulation of air, continues to burn in oxygen gas, after being withdrawn from the focus.

The light it affords is steady, and of so brilliant a red, as to be visible in the brightest sunshine; and the heat produced is so great, that in one experiment, in which three fragments of diamonds weighing 1.84 grains only were burnt, a fine wire of platinum used for attaching them to the tray was fused, and that some time after the diamonds were removed out of the focus.

From the results of different experiments, it appears evident, that the diamond affords no other substance by its combustion than pure carbonic acid gas; and that the process is merely a solution of diamond in oxygen, without any change in the volume of the gas; for the slight absorption in the second experiment is scarcely more than a compensation for the volume occupied by the diamonds consumed.

It is likewise evident, that in the combustion of the different kinds of charcoal, water is produced; and from the diminution of the volume of the gas, there is every reason to believe, that the water is formed by the combustion of hydrogen existing in the charcoal.

The only chemical difference perceptible between diamond and the purest charcoal, is, that the last contains a minute portion of hydrogen; but can a quantity of an element, less in some cases than $\frac{1}{50000}$ part of the weight of the substance, occasion so great a difference in physical and chemical characters? This is possible, yet it is contrary to analogy; and I am more inclined to adopt the opinion of Mr. Tennant, that the difference depends upon crystallisation. Transparent solid bodies are in general non-conductors of electricity, and it is probable that the same corpuscular arrangements which give to matter the power of transmitting and polarising light, are likewise connected with its relations to electricity; and water, the hydrates of the alkalies, and a number of other bodies which are conductors of electricity when fluid, become non-conductors in their crystallised form.

A small diamond, weighing .45 of a grain, was kept in a state of intense ignition, by the great lens of the Florentine Museum, in hydrogen gas for more than half an hour; but the gas suffered no change, and the diamond had undergone no diminution of weight, and was not altered in appearance. Charcoal, after being intensely ignited in chlorine, is not altered in its conducting power or colour; and this circumstance is in favour of the opinion, that the minute quantity of hydrogen is not the cause of the great difference between the physical properties of the diamond and charcoal.

Observations on the Functions of the Brain. By Sir EVERARD HOME, *Bart.*

BEFORE I enter into the particular effects that take place when pressure is made upon the brain by means of water, it is necessary, to mention, that sudden pressure of any kind upon the cerebrum takes away all sensibility, whether made upon the external surface through the medium of the dura mater, or upon the internal parts through the medium of the ventricles, and sensibility returns as soon as the unusual pressure is removed.

Although insensibility is the common effect of undue pressure upon the *cerebrum*, it appears, from what will be stated, that it is not a necessary consequence of undue pressure upon the *cerebellum*.

Concussion of the brain produces delirium and coma; these symptoms may go off, and yet, sometimes, in a few day's return and prove fatal. In the torpid state commonly attendant upon any violent shake being given to the brain, the senses are so much impaired, that little information can be gained respecting the effects produced upon the internal organs.

Sudden dilatation of the blood-vessels of the cerebrum, in consequence of exposure to the sun, is sometimes accompanied by delirium, loss of speech, and the power of swallowing A dilated state of the veins of the cerebrum has been attended with head-aches, which are very severe when the body is placed in a horizontal posture.

When the smaller arteries of the cerebrum are preternaturally enlarged, while those of the cerebellum are not, delirium has taken place, followed by a fit resembling apoplexy, and a paralytic affection of one side.

An obstruction to the passage of the blood through the right internal carotid artery, was attended by a succession of slight apoplectic fits, unaccompanied by any paralytic affection.

A deep wound into the right anterior lobe of the brain, attended with inflammation and suppuration, produced no sensation whatever; the senses remained entire, and the person did not know that the head was injured.

The brain shooting out in the form of fungus, after the dura mater is wounded, has no effect upon any of the nerves, nor is it attended with sensation; but the inflamed pia mater gives great pain.

Loss of a portion of the medullary substance of the anterior lobe of the cerebrum, produced no symptoms. Loss of a

portion of one of the hemispheres was attended with difficulty of swallowing for twenty-four hours, and slight delirium of short duration. Ulceration of the anterior lobe of the brain, as low as the anterior cornu of the lateral ventricle, but not communicating with it, was attended with paralysis of both arms.

In a case of a penetrating wound into the right hemisphere of the brain, with bone forced into its substance, while there was an opening for the discharge of matter, no effects were produced, except when the circulation was much increased; and then only head-ache and numbness in the left side.

Pressure upon the medulla spinalis in the neck, by coagulated blood, produced paralytic affections of the arms and legs; all the functions of the internal organs were carried on for thirty-five days, but the urine and stools passed involuntarily.

Blood extravasated in the central part of the medulla in the neck, was attended with paralytic affection of the legs but not of the arms.

In a case where the substance of the medulla was lacerated in the neck, there was paralysis in all the parts below the laceration; the lining of the œsophagus was so sensible, that solids could not be swallowed, on account of the pain they occasioned.

Where the medulla in the back was completely divided, there was momentary loss of sight, loss of memory for fifteen minutes, and permanent insensibility in all the lower parts of the body. The skin above the division of the spinal marrow perspired; that below did not. The wounded spinal marrow appeared to be extremely sensible.

On the Nature and Cause of the Pulse. By Dr. Parry.

Dr. P. takes a review of the different theories which have been proposed to account for the phenomenon of pulsation, observing that the greater part of physiologists had contented themselves with the opinion of Haller, that pulsation was occasioned by the diastole and systole of the heart.

His view, however, of the question is much simpler; on examining different arteries where they were exposed to no obstruction or pressure, he found that they had no pulse: by pressing the finger on an artery over a soft part of the body, which yielded sufficiently to the pressure, no pulse was manifested; but whenever an artery was pressed over a solid part, then a pulse was immediately found. He repeated these operations several times, and uniformly found the same effects

Hence he concludes, that the pulse is nothing more than the re-action or impetus of the blood to maintain its regular motion. The arteries appear only as canals through which the blood flows in a uniform and continuous current: diminish the diameter of the canals, and a pulse is immediately perceived. At every junction of a vein with an artery, the internal diameter of the latter is diminished, and hence a pulse always appears

Experiments and Observations on the Colours used in Paintings by the Ancients. By Sir H. Davy.

The works of Theophrastus, Dioscorides, Vitruvius, and Pliny, contain descriptions of the substances used by the ancients as pigments; but hitherto, I believe, no experimental attempt has been made to identify them, or to imitate such of them as are peculiar. The experiments of this philosopher have been made upon colours found in the baths of Titus, and the ruins called the baths of Livia, and in the remains of other palaces and baths of ancient Rome, and in the ruins of Pompeii. He was enabled to select with his own hands specimens of the different pigments that have been found in vases discovered in the excavations lately made beneath the ruins of the palace of Titus, and to compare them with the colours fixed on the walls, or detached in fragments of stucco; and he was allowed actually to make experiments upon the colours of the celebrated picture "Nozze Aldobrandine;" but he adds, "When the preservation of a work of art was concerned, I made my researches upon mere atoms of the colour, taken from a place where the loss was imperceptible: and, without having injured any of the precious remains of antiquity, I flatter myself I shall be able to give some information, not without interest to scientific men as well as to artists, and not wholly devoid of practical applications."

Of the Red Colours of the Ancients.—Of these, three species are mentioned; one bright and approaching to orange; another dull-red; and a third, a purplish-red. On exposing the bright-red to the flame of alcohol, it became darker-red; and on increasing the heat by a blow-pipe, it fused into a mass having the appearance of litharge, and which was proved to be this substance by the action of sulphuric and muriatic acids: this colour is consequently minium, or the red oxide of lead. By other processes, which are particularly described, he found that the dull red colour is an iron ochre,

and the purplish-red was proved to be an ochre of a different tint.

In examining the fresco-paintings in the baths of Titus, he found that these colours had been all used, the ochres in particular, in the shades of the figures, and the minium in the ornaments on the borders. He found another red on the walls, of a tint different from those in the vase, and much brighter, and which had been employed in various apartments, and formed the basis of the colouring of the niche, and other parts of the chamber in which the Laocoon is said to have been found: this proved to be vermilion or cinnabar; for, on heating it with iron filings, quicksilver was procured.

In the picture already mentioned, the "Nozze Aldobrandine," the reds are all ochres: on these reds the action of acids, of alkalies, and of chlorine could discover no traces either of minium or vermilion in the picture.

Of the Yellows of the Ancients. — A large earthen pot, found in one of the chambers of the baths of Titus, contained a quantity of yellow paint, which, when submitted to chemical examination, proved to be a mixture of yellow ochre with chalk. There were three different yellows; two of them proved to be yellow ochres mixed with chalk in different proportions; and the third, a yellow ochre, mixed with red oxide of lead or minium.

Of the Blue Colours of the Ancients. — Different shades of blue are used in the different apartments of the baths of Titus, and several very fine blues exist in the mixtures of their colours. These blues are of different hues, according as they contain larger or smaller quantities of carbonate of lime; but, when this carbonate is dissolved by acids, they present the same body colour, a very fine blue powder, similar to the best smalt or ultramarine, rough to the touch, and which does not lose its colour by being heated to redness; but which becomes agglutinated and semifused at a white heat.

Of ancient Greens. — The deep sea-green colouring matter, taken from the ceiling of the chambers called the baths of Livia, proved to be soluble in acids, with effervescence; and when precipitated from acids, it was re-dissolved in solution of ammonia, giving it a bright blue, produced by copper. There are several different shades of green employed in the baths of Titus, and on the fragments found near the monument of Caius Cestius: there were three different varieties; one, which approached to olive, was the common green earth of Verona; another, which was a pale grass green, had the

character of carbonate of copper, mixed with chalk; and a third, which was a sea green, was a combination of copper mixed with the blue copper frit.

Of the Purple of the Ancients.—This was regarded as their most beautiful colour, and was prepared from shell-fish. According to Vitruvius, the colour differed according to the country from which the shell-fish was brought; that it afforded a colour deeper and more approaching to violet from the northern countries, and a redder colour from the southern coasts. The finest purple had a tint like that of a deep-coloured rose: and in painting, it was laid on to give the last lustre to the sandyx, a composition made by calcining together red ochre and sandarach, and which, it is inferred, must have been nearly the same as our crimson.

An Account of some Experiments with a large Voltaic Battery. By J. G. Children, Esq. F.R.S.[a]

The copper and zinc plates of this apparatus are connected together in the usual order by leaden straps; they are six feet long, by two feet eight inches broad, each plate presenting 32 square feet of surface. All the plates are attached to a strong wooden frame, suspended by ropes and pulleys, which, being balanced by counterpoises, is easily lowered and elevated, so as to immerse the plates in the acid, or raise them out of it at pleasure.

The first trials of the power of this instrument were made in July 1813, in the presence of several philosophical friends; but the effects then fell very short of my expectations, arising, as I afterwards found, from a defect in the construction, which has been since remedied, and another copper-plate added to each member of the series, so that every cell now contains one zinc and two copper-plates, and each surface of zinc is opposed to a surface of copper.

The battery was moderately excited by a charge of one part acid, diluted with 40 parts of water.

Exp. 1. A platina and a gold wire being connected and introduced into the electrical circuit, the platina was instantly ignited; the gold remained unaffected.

Exp. 2. A similar arrangement of gold and silver wires. The gold was ignited, the silver not.

Exp. 3. The same with gold and copper. No perceptible difference in the state of ignition; both metals were heated red.

Exp. 4. Gold and iron. The iron was ignited; the gold unchanged.

Exp. 5. Platina and iron. The iron ignited instantly at the point of contact, next the pole of the battery. Then the platina became ignited through its whole extent. After this the iron became more intensely heated than the platina, and the ignition of the latter decreased.

Exp. 6. Platina and zinc. The platina was ignited: the zinc was not; but melted at the point of contact. In a subsequent experiment, the zinc did not melt; but the platina ignited as before.

Exp. 7. Zinc and iron. The iron was ignited: the zinc bore the heat without fusing.

Exp. 8. Lead and platina. The lead fused at the point of contact.

Exp. 9. Tin and platina. The tin fused at the point of contact. No ignition of either wire took place in the two last experiments.

Exp. 10. Zinc and silver. The zinc was ignited before it melted: the silver was not ignited.

Exp. 11. Alternations of platina and silver, three times repeated: all the platina wires were ignited, and none of the silver.

Exp. 12. One zinc wire between two platina: both the platina wires were ignited, the zinc not.

Exp. 13. One iron between two platina. Both the latter first ignited; then the iron, which soon became most heated and fused.

From the foregoing results, the order of the conducting powers of the metals tried is silver, zinc, gold, copper, iron, and platina. Tin and lead fuse so immediately at the point of contact, that they cannot be placed. Between gold and copper the difference is trifling; and with regard to platina and iron, their relations to each other, in this circumstance, seem to be affected by elevation of temperature. It may be observed, that the order of the above metals, as conductors of electricity, nearly follows that of their powers to conduct heat.

In an experiment in which equal lengths of two platina wires, of unequal diameter, (the larger being $\frac{1}{30}$, the smaller $\frac{1}{50}$ of an inch,) were placed together in the circuit parallel to each other, the thicker wire was ignited, because it conveyed more electricity without proportional increase of cooling surface. When connected continuously, the order of ignition was reversed.

The experiments which I now proceed to mention, were made with the battery in a high state of excitation; and I consider them as representing nearly the maximum of effect which it is capable of producing. As the quantity of acid was increased from time to time, and that previously added, often almost spent before fresh was put in, it is not easy to say exactly what proportion it bore to the water; perhaps the largest may be stated at about $\frac{1}{20}$. On this, as on former occasions, I found a mixture of nitrous and sulphuric acids to produce the most powerful and permanent effects.

Exp. 1. Five feet six inches of platina wire, $\frac{11}{100}$ of an inch in diameter, were heated red throughout, visible in full daylight.

Exp. 2. Eight feet six inches of platina wire, $\frac{14}{100}$ of an inch in diameter, were heated red.

Exp. 3. A bar of platina, one-sixth of an inch square, and 2¼ inches long, was also heated red, and fused at the end; and,

Exp. 4. A round bar of the same metal, $\frac{276}{1000}$ of an inch in diameter, and 2½ inches in length, was heated bright-red throughout.

Exp. 5. Fine points of boxwood charcoal intensely ignited in chlorine, neither suffered any change, nor produced any in the gas. The result was similar when heated in azote.

I endeavoured to ascertain if there be any difference in the degree of heat produced at either pole of the battery, by placing two small earthenware cups, each containing an equal weight of mercury, in the circuit, and connected together by a platina wire of such size and length as to be kept constantly ignited. The mercury in the cup connected with the zinc end of the battery attained, in 20 minutes, temperature of 121°, that in the other cup 112°.

The battery, even in its most active state, communicated no charge to the Leyden phial.

On the Safety Lamp. By Sir Humphrey Davy.

In an introduction to his paper on the subject, Sir Humphry Davy observes, that it is impossible to converse with persons in the neighbourhood of the collieries where explosions have happened from the fire-damp, and not to be strongly affected by the accounts they give of the destruction of human life, and the variety of human misery, which have been produced by these dreadful accidents. By a single explosion in the Felling colliery 94 persons were destroyed, and nearly as many

families plunged into deep distress; and the frequency of the occurrence of these catastrophes, notwithstanding the improvements in the ventilation of the mines, and the continued activity of the persons concerned in the care of the works, had almost produced a feeling of despair in the minds of many benevolent persons as to the possibility of finding a remedy sufficiently simple and economical to be used in the mines.

When he found that explosive mixtures, admitted through narrow metallic canals, brought in contact with flame, burnt only at the surface where they issued, he had hopes of keeping up a constant flame from explosive mixtures issuing from tubes or canals; but, on trying this, even in atmospherical air, it failed. Conceiving that the failure was owing to the great cooling powers of the metallic sides of the canal, it occurred to him to try the metallic wire-flame sieves, and with these he had perfect success.

He inclosed a very small lamp in a cylinder made of wire-gauze, having 640 apertures in the square inch, and closed all apertures except those of the gauze, and introduced the lamp burning brightly within the cylinder into a large jar, containing several quarts of the most explosive mixture of gas, from the distillation of coal, and air; the flame of the wick immediately disappeared, or rather was lost, for the whole of the interior of the cylinder became filled with a feeble, but steady, flame of a green colour, which burnt for some minutes, till it had entirely destroyed the explosive power of the atmosphere.

Wire-gauze may therefore be substituted for horn or glass in the safe-lanterns, or safe-lamps to be used in the collieries, and no air-feeders below the flame will be necessary. The wire-gauze admits a free circulation of air, while it emits considerably more light than common horn. Sir Humphry has had small cylindrical caps of wire-gauze made to fit small lamps by a screw, which are almost as portable as a common candle without a candlestick; and which are trimmed and supplied with oil through safe apertures, without the necessity of taking off the cap. A similar cap may be used with the common candles of the colliers introduced by an aperture made tight with moist pipe-clay. Brass-wire gauze of the proper degree of fineness is manufactured for the use of mills and for sieves. Gauze which contained 3600 apertures in a square inch, is sufficiently fine to prevent explosion used as a cylinder; but it did not bear the proof of a concentred explosion from a close glass vessel. Gauze of 5000 apertures to the square inch stood, however, this severe test. He has

generally used gauze of 6400 apertures; and he has seen plated wire-gauze, which is sold at Edinburgh, so fine, that the square inch contains 13,200 apertures.

With the wire-safe-lamp, or guarded candle, the miner may explore all parts of the mine where explosive mixtures exist, and the state of the flame will show him the degree of contamination of the air. As the fire-damp mixes with the air, the flame will enlarge. When the fire-damp has reached its explosive point, his cylinder will be filled with flame; but the flame of his wick will appear within the flame of the fire-damp. As the inflammable gas increases in quantity, the flame of the lamp will disappear, and the flame in his cylinder will become paler; and this ought to be a signal to him to leave that part of the workings. For when the flame of the fire-damp is extinguished, though the air may be sufficiently respirable to enable him to make good his way, yet it cannot be breathed safely for any considerable length of time.

Thus it appears from these experiments, that no new lamp or other apparatus is necessary to prevent explosions; that the lamps now in use, when covered with a wire-gauze screen, are not only perfectly sufficient to preserve the miners from all danger, but even may be used to consume the fire-damp by burning it to show them light. By surrounding the lamp with a fine wire-gauze screen, saturating the screen with fire-damp and inflaming the whole, the wire, if fine, and the apertures not exceeding $\frac{1}{30}$th of an inch, may be made red hot without exploding the circumambient fire-damp. With a small portion of fire-damp in the screen, the flame of the lamp is visible; but when a considerable portion is thrown into it, the whole becomes one entire flame. In this manner the carburetted hydrogen gas may be burned under the screen without the least danger of exploding the gas around it.

The present paper contains a variety of experiments to ascertain the smallest number of apertures in a square inch which can be used without danger of exploding. Wire-gauze having apertures $\frac{1}{10}$th of an inch, when the wire became red hot, exploded; but gauze with apertures only of $\frac{1}{50}$ were perfectly secure even with the greatest heat. In some of his experiments, Sir Humphry used gauze having 6000 apertures in a square inch, which was found as perfectly secure as a brick wall could have been against explosion.

On the Influence of the Nerves. By Dr. Wilson Philip.

It has been long known that when the nerves which supply the voluntary muscles are deranged or divided, the powers of the muscle are interfered with, and that any injury done to the nerves which supply the organs of secretion, interrupt or modify the functions of the gland, and the composition of the secretion.

That the function of digestion is connected with the operation of the eighth pair of nerves, Dr. Philip proves by feeding rabbits with parsley, and immediately after dividing those nerves in the neck. After some hours the animal was killed, and the parsley found unchanged in the stomach. In another experiment the rabbit was fed, and the nerves divided as before; their extremities were covered with tin foil, and the hair opposite the stomach being removed, a shilling was laid upon that spot; the foil and the shilling were then connected with a battery of 47 four-inch plates, the action of which was continued by dilute muriatic acid for twenty-six hours, when the animal was killed, and the parsley was as perfectly digested, says Dr. Philip, as in the stomach of a healthy rabbit. Hence Dr. Wilson Philip concludes, that nervous influence and galvanic influence are identical.

The remainder of the paper relates principally to the generation of heat in animals, which Dr Philip refers, with Mr. Brodie, to the influence of the nerves. He considers animal heat as a secretion.

Some Account of the Feet of those Animals whose progressive Motion can be carried on in Opposition to Gravity. By Sir Everard Home.

The lacerta gecko, a native of Java, possesses this power: it is an animal of considerable size, weighing above five ounces. Each foot has five toes, which terminate in a crooked claw: round the toe there are a set of transverse openings or pockets with serrated edges. When these attach themselves to the wall, the pockets are extended by a set of muscles adapted for the purpose; a vacuum is formed in each, and the consequent pressure of the air is sufficient to keep the foot attached to the wall, and to support the weight of the animal. The structure of the top of the head of the echineis remora, or sucking-fish, and the structure of the feet of flies, must be similar.

Of the Construction and Extent of the Milky Way. By Sir W. Herschel.

Of all the celestial objects, consisting of stars not visible to the eye, the milky way is the most striking; its general appearance, without applying a telescope to it, is that of a zone, surrounding our situation in the solar system, in the shape of a succession of differently-condensed patches of brightness, intermixed with others of a fainter tinge.

The breadth of the milky way appears to be very unequal. In a few places it does not exceed five degrees; but, in several constellations, it is extended from 10 to 16. In its course it runs nearly 120 degrees in a divided clustering stream, of which the two branches between Serpentarius and Antinous are expanded over more than 22 degrees

That the sun is within its plane, may be seen by an observer, in the latitude of about 60 degrees; for, when at 100 degrees of right ascension, the milky way is in the east, it will, at the same time, be in the west at 280; while, in its meridional situation it will pass through Cassiopea in the Zenith, and through the constellation of the cross in the Nadir.

From this survey of the milky way by the eye, I shall now proceed to show what appears to be its construction, by applying to it the extent of telescopic vision.

From the formula which has been given, I calculated a set of apertures, which, by limiting the light of the finder of my seven-feet reflector, would reduce its space-penetrating power to the low gauging powers two, three, and four. I then limited, in the same manner, the space-penetrating power of my night-glass, by using calculated apertures, such as would give the gauging powers five, six, seven, and eight. From the space-penetrating power of the seven-feet reflector, I obtained, by limitation, the successive gauging powers nine, ten, and upwards, to seventeen. And lastly, by limiting the space-penetrating power of my ten-feet reflector, I carried the gauging powers from seventeen to twenty-eight.

With a ten-feet reflector, reduced to a gauging power of 18, I saw a great number of stars: they were of very different magnitudes, and many whitish appearances were so faint, that their consisting of stars remained doubtful. The power 19, which next I used, verified the reality of several suspected stars, and increased the lustre of the former ones. With 20, 22, and 25, the same progressive verifications of suspected stars took place; and those which had been verified

by the preceding powers, received subsequent additional illumination. With the whole space-penetrating power of the instrument, which is 28.67, the extremely faint stars in the field of view acquired more light, and many still fainter suspected whitish points could not be verified for want of a still higher gauging power. The stars which filled the field of view were of every various order of telescopic magnitudes; and were probably scattered over a space extending from the 201th to the 344th order of distances.

From the great diameter of the mirror of the 40-feet telescope, we have reason to believe, that a review of the milky way with this instrument would carry the extent of this brilliant arrangement of stars as far into space as its penetrating power can reach, which would be to the 2300dth order of distances; and that it would then probably leave us again in the same uncertainty as the 20 feet telescope.

What has been said of the extent and condition of the milky way, in several of my papers on the construction of the heavens, with the addition of the observations contained in this attempt, to give a more correct idea of its profundity in space, will nearly contain all the general knowledge we can ever have of this magnificent collection of stars. To enter upon the subject of the contents of the heavens, in the two comparatively vacant spaces on each side adjoining the milky way, the situation of globular clusters of planetary nebulæ, and of far extended nebulosities, would greatly exceed the compass of this paper; I shall therefore only add one remarkable conclusion, that may be drawn from the experiments which have been made with the gauging powers.

Let a circle, drawn with the radius of the twelfth order of distances, represent a sphere containing every star that can be seen by the naked eye; then, if the breadth of the milky way were only five degrees, and if its profundity did not exceed the 900dth order of distances, the two parallel lines in the figure, representing the breadth of the milky way, will, on each side of the centre of the inclosed circle, extend to more than the 39th order of distances.

From this it follows, that not only our sun, but all the stars we can see with the eye, are deeply immersed in the milky way, and form a component part of it.

Astronomical Observations and Experiments, selected for the Purpose of ascertaining the relative Distances of Clusters of Stars, and of investigating how far the Power of our Telescopes may be expected to reach into Space, when directed to ambiguous celestial Objects. By Sir Wm. Herschel.

In my last paper on the local arrangement of the celestial bodies in space, I have shown how, by an equalisation of the light of stars of different brightness, we may ascertain their relative distances from the observer, in the direction of the line in which they are seen; and from this equalisation, a method of turning the space-penetrating power of a telescope into a gradually increasing series of gauging powers has been deduced, by which means the profundity in space, of every object consisting of stars, can be ascertained, as far as the light of the instrument which is used upon this occasion will reach.

When the nature or construction of a celestial object is called ambiguous, this expression may be looked upon as referring either to the eye of the observer, or to the telescope by which it has been examined.

If a cluster of stars in a very small telescope will appear like a star with rather a larger diameter than stars of the same size generally have, we shall certainly be authorised to conclude, that an object seen in a larger and more perfect telescope as a star with rather a larger diameter, is also an ambiguous object, and might possibly be proved to be a cluster of stars, had we a superior instrument by which we could examine its nature and construction.

This seems to throw some light upon a species of objects called stellar nebulæ, 140 of which have been inserted in my catalogues. For, as it has just been mentioned, that a 10-feet telescope may become a finder to a 20-feet one, the 20-feet telescope itself will be but a finder to objects that are so far out of its reach as not to appear otherwise than ambiguous; nay, the 40-feet telescope, when it is but just powerful enough to show the existence of an object which decidedly differs from the appearance of a star, may then truly be called a finder.

Celestial objects can only be said to remain ambiguous, when the telescopes that have been directed to them leave it undetermined whether they are composed of stars or of nebulous matter.

In 10 observations, the gauges applied to the milky way were found to be arrested in their progress by the extreme

smallness and faintness of the stars; this can, however, leave no doubt of the progressive extent of the starry regions; for when, in one of the observations, a faint nebulosity was suspected, the application of a higher magnifying power evinced that the doubtful appearance was owing to an intermixture of many stars that were too minute to be distinctly perceived with the lower power; hence we may conclude, that when our gauges will no longer resolve the milky way into stars, it is not because its nature is ambiguous, but because it is fathomless.

In the depth of the celestial regions, we have hitherto only been acquainted with two different principles, — the nebulous and the sidereal. The light of the nebulous matter is comparatively very faint, and, except in a few instances, invisible to the eye. It is also in general widely diffused over a great expanse of space, in which, by an increase of faintness, it generally escapes the sight: the light of stars, on the contrary, is comparatively very brilliant, and confined to a small point, except when many of them are collected together in clusters, when their united lustre sometimes takes up a considerable number of minutes of space; but in this case the stars of them may be seen in our telescopes; and by the observations that have been given, it appears that when they are viewed with instruments gradually inferior to those which prove them to be clusters of stars, their diameters, seen with less light and a smaller magnifying power, are generally contracted; a globular cluster is reduced to a cometic appearance, to an ill-defined star surrounded by nebulosity, and to a mere small star with rather a larger diameter than stars of the same size generally have. In consequence of these considerations, it seems to be highly probable that some of the cometic, many of the planetary, and a considerable number of the stellar nebulæ, are clusters of stars in disguise, on account of their being so deeply immersed in space, that none of the gauging powers of our telescopes have hitherto been able to reach them. The distance of objects of the same appearances, but which are of a nebulous origin, on the contrary, must be so much less than that of the former, that their profundity in space may probably not exceed the 900dth order.

The method of equalising the light of stars on which the gauging power of telescopes has been established, may also be applied to give us an estimate of the extent of their power to reach ambiguous celestial objects.

When the united light of a cluster of stars is visible to the eye, there will then be a certain maximum of distance to which

the same cluster might be removed, so as still to remain visible in a telescope of a given space-penetrating power; and if the distance of this cluster can be ascertained by the gauging power of any instrument that will just show the stars of it, the order of the profundity, at which the cluster could still be seen as an ambiguous object, may be ascertained by the space-penetrating power of the telescope through which it is observed. But as the aggregate brightness of the stars depends entirely on their number and arrangement, this method can only be used with clusters of stars that have been actually observed.

On the Anomaly in the Variation of the Needle. By Captain SCORESBY.

THE following are the results of his observations:

All the iron on board a ship has a tendency to become magnetical, the upper ends of the opposite bars being south, and the lower north poles in the northern hemisphere, and *vice versâ.*

The combined influence of all the iron is concentrated into a focus, the principal south pole of which being upward in the northern hemisphere, is situated in general near the middle of the upper deck.

This focus of attraction, which appears to be a south pole in north dip, attracts the north point of the compass, and produces the deviation in the needle.

This deviation varies with the dip of the needle, the position of the compass, and the direction of the ship's head. It increases and diminishes with the dip, and vanishes at the magnetic equator. It is a maximum when the ship's course is west or east, and it is proportional to the sines of the angles between the ship's head and the magnetic meridian.

A compass placed in either side of the ship's deck, directly opposite to the focus, gives a correct indication on an east or west course, but is subject to the greatest deviation when the ship's head is north or south.

Theory of Mists. By Sir H. DAVY.

LAND and water are cooled after sunset in a very different manner. The impression of cooling on the land is limited to the surface, and is very slowly transmitted into the interior; whereas in water the upper stratum, when cooled, descends, and has its place supplied by warmer water from below. The

surface of the water will, therefore, in calm and clear weather, and in temperatures above 45° Fahr., be warmer than that of the contiguous land; and, consequently, the air above the land will be cooler than that above the water. When the cold air, therefore, from the land mixes with that above the water, both of them containing their due proportion of aqueous vapour, a mist or fog must be the result.

On the Geology of Plymouth and its Vicinity. By Mr. Whidbey.

The mountain limestone of Plymouth lies directly upon clay-slate, and is remarkably scanty in organic remains: it includes certain caverns, perfectly insulated, some of which are incrusted with stalactite, and present nothing remarkable. In others, the author has discovered certain fossil bones in caves without any stalactical incrustation, having only a little dry clay at the bottom. "The cavity was entirely surrounded by compact limestone rock, about eight feet above high water mark, 55 feet below the surface of the rock, 174 yards from the original face of the quarries, and about 120 yards in that direction from the spot where the former bones were found in 1816." The bones are those of the rhinoceros, the bear, and an animal of the deer kind, and of another animal of the size of the bear.

The Croonian Lecture; or, Microscopical Observations on the Brain and Nerves. By Sir Everard Home, Bart.

This paper shows that the materials of which the brain and nerves are composed exist in the blood. Bauer examined the optic nerve, and found it to consist of many bundles of fine fibres, formed of very minute globules united by a soluble transparent jelly. "By the discovery of this transparent substance," says Sir Everard, "we become acquainted with the nature of the medullary structure of the nerves, and can form some idea of their action, which till now I confess myself to have been totally unacquainted with. The nerves as well as the retina are composed of this newly discovered transparent substance, which is very elastic and soluble in water, and globules of $\frac{1}{2800}$ and $\frac{1}{1600}$ parts of an inch in diameter. Its transparency and solubility account for its having remained concealed; and were it not coagulable, in which state it becomes opaque, its existence might even now

be considered as equivocal." The brain is also, according to Bauer, a conglomerate of globules and soluble mucus; the former arranged into fibres and bundles, held together by the latter. It is pervaded by blood-vessels, but the arteries never anastomose, and the veins, which are very small, are supplied with valves, and perform the office of lymphatics, carrying the absorbed matter into the superior longitudinal sinus.

"That the cortical part of the brain is the seat of memory, is an opinion," says Sir Everard, "which I have long entertained, from finding that any continued undue pressure upon the upper anterior part of the brain entirely destroys memory, and a less degree materially diminishes it. Pressure upon the dura mater, where the skull has been trepanned, puts a temporary stop to all sense, which is restored the moment that pressure is removed; and the organ appears to receive no injury from repeated experiments of this kind having been made. In hydrocephalus, when the fluid is in large quantity, and there only remains the cortical part of the brain and the pons Varolii connecting it to the cerebellum, all the functions go on, and the memory can retain passages of poetry, so as to say them by heart; but a violent shake of the head produces instant insensibility. Pressure in a slight degree produced in one case complete derangement, with violent excess of passion, both of which went off upon removing, by the crown of the trepan, the depressed bone."

And adverting to the abundance and office of the transparent mucus, Sir Everard says, "There can be no doubt that the communication of sensation and volition more or less depend upon it." Indeed, it is evident that those functions cannot be ascribed to any individual component of the brain and nerves, but belong to them as entire structures.

The remainder of this part of the lecture is taken up in attempting to show that the above-mentioned mucus exists ready formed in the blood, and that it is the medium "by which the colouring matter is attached to the surface of the red globules;" and that fat may exist in the blood. The next portion of this lecture is devoted to the provision for carrying off the fluids taken into the stomach, whenever the quantity or quality interferes with the process of digestion. "To do this by the route of the thoracic duct was not only too circuitous to correspond with the general simplicity of the operations of nature, but was mixing these heterogeneous liquids in too crude a state, with the general circulation of the blood. That there was some unusual mode of conveying fluids from the stomach to the urinary bladder, I have upon

a former occasion established, since they arrived there when both the pylorus and thoracic duct were tied up, and the spleen was removed out of the body; but till the fact of valvular vessels supplying the office of absorbents was ascertained, any opinion respecting the route of fluids from the stomach must continue to be entirely hypothetical."

Sir Everard then demonstrates the existence of such vessels, and describes their situation and appearance, by engravings of Bauer's drawings.

"To show the course of the absorbed fluids, as well as to give a clear idea of every thing connected with so important a discovery, a drawing of the spleen, the vas breve, and cardiac portion of the stomach, is annexed; and as the trunk of the splenic vein forms one of the trunks of the vena portæ, the liquids are directly carried to the liver, forming a part of the materials employed in producing the bile; the remainder only returning by the vena cavâ to the heart.

"This additional quantity of liquids passing along the splenic vein accounts for its being five times the size of the artery, as well as for the blood in that vein having a greater proportion of serum than the blood in any other, which has been long asserted, and which I found by actual experiments to be the case; but being unable to account for it, as I can now, I was willing to admit that the mode of measuring might be erroneous."

The spleen is then shown to consist of blood-vessels, between which there is no cellular membrane, the interstices being filled with serum, and with the colouring matter of the blood from the lateral orifice in the veins, when these vessels are distended; which serum is afterwards removed by the absorbents belonging to the organ, and carried into the thoracic duct by a very large absorbent trunk; so that from this mechanism "the spleen appears to be a reservoir for the superabundant serum, lymph globules, soluble mucus, and colouring matter, carried into the circulation immediately after the process of digestion is completed."

The Bakerian Lecture, on the Composition and Analysis of the inflammable gaseous Compounds resulting from the destructive Distillation of Coal and Oil; with some Remarks on their relative heating and illuminating Powers. By WILLIAM THOMAS BRANDE, *Esq.*

THE gases used in the following experiments, except where it is otherwise expressly stated, were those employed

for the common purposes of illumination; the coal gas being that supplied from the Company's works in Westminster; and the oil gas furnished by the decomposition of common whale oil, in an apparatus erected for that purpose at Apothecaries' Hall.

My first object, in the examination of coal gas, was to ascertain its specific gravity; and the first that I examined was so low as .4430, and purified in the usual way, by condensation in cold vessels, and passing through lime water, it was as high as .4940.

Having filled the gasometer with pure olefiant gas, it was allowed to issue from a brass jet, having a single perforation of $\frac{1}{60}$ of an inch diameter, under a pressure of a half inch column of water; it was then inflamed, and regulated by means of a stop-cock, so as to produce a light equal to that of a wax candle burning with full brilliancy; the relative intensity of the light of these flames was ascertained by a comparison of shadows. Under these circumstances, the consumption of gas was found = 640 cubical inches per hour, or 0.37 cubical feet. When the same burner was used with oil-gas, it consumed 800 cubical inches per hour, or = 0.47 cubical feet.

I now employed an Argand burner, with a cylindrical glass, constructed in the usual way, with 12 holes, each of the same dimensions as that of the single jet, and forming a circle 0.7 inch diameter. The pressure being 0.5 inch, the flame was so regulated as to burn with its full intensity without producing smoke, and its light being measured by a comparison of shadows, it was found equal to 10 wax candles. The consumption of gas amounted to 2600 cubical inches, or about a cubical foot and a half per hour.

The apertures of burners for coal gas require to be considerably larger than those for olefiant or oil gas. In the burner employed in the following experiments, each hole was $\frac{1}{30}$ inch diameter, and the circle upon the circumference of which they were placed, was 0.9 inch diameter. The light of the flame was found equal to five wax candles only, and the consumption of gas per hour amounted to 6560 cubical inches.

With a mixture of six parts by measure of hydrogen with five of olefiant gas, the light of the flame was somewhat more intense; and the quantity of gas consumed by the same burner, so adjusted as not to smoke, was 6000 cubical inches.

It appears from the above data, that to produce the light of 10 wax candles for one hour, there will be required, —

2600 cubical inches of olefiant gas.
4875 - - - oil gas.
13120 - - - coal gas;

and that the quantity of oxygen consumed

by the olefiant gas will be = 7800 cubic inches.
by the oil gas - - = 11578.
by the coal gas - - = 21516.

To ascertain the relative heating powers of the flames of olefiant oil, and coal gases, I employed the 12-hole Argand burners mentioned above, and placed over each, as near to the lamp glass as was consistent with a clear flame, a clean copper boiler, 2.5 inches deep and five inches in diameter, slightly concave at bottom, capable of holding rather more than a quart of water, with an immersed thermometer, and a small vent for steam. It contained two pounds of distilled water, which was raised to the boiling point in similar times, namely, 20′ by each of the flames; so that it would appear, that to raise a quart of water from 50° to 212°, at 30 inches barometrical pressure, requires

870 cubical inches of olefiant gas.
1300 - - - oil gas.
2190 - - - coal gas.

From this experiment it may be inferred, that the air of a room equally lighted by oil and coal gas, will be much less heated by the former than the latter; but that the actual heating power of the flames is in the direct ratio of the quantity of olefiant gas.

Experiments on the Condensation of several Gases into Liquids. By Mr. Faraday.

Mr. Faraday's experiments were made on sulphurous acid, sulphuretted hydrogen, carbonic acid, euchlorine, nitrous oxide, cyanogen, ammonia, muriatic acid, and chlorine.

Sulphurous Acid — Mercury and concentrated sulphuric acid were sealed up in a bent tube, and, being brought to one end, heat was carefully applied, whilst the other end was preserved cool by wet bibulous paper. Sulphurous acid gas was produced where the heat acted, and was condensed by the sulphuric acid above; but when the latter had become saturated, the sulphurous acid passed to the cold end of the tube, and was condensed into a liquid. When the whole tube was cold, if the sulphurous acid was returned on to the mixture

of sulphuric acid and sulphate of mercury, a portion was re-absorbed, but the rest remained on it without mixing.

Liquid sulphurous acid is very limpid and colourless, and highly fluid. Its refractive power, obtained by comparing it in water and other media, with water contained in a similar tube, appeared to be nearly equal to that of water. It does not solidify or become adhesive at a temperature of 0° F. When a tube containing it was opened, the contents did not rush out as with explosion, but a portion of the liquid evaporated rapidly, cooling another portion so much as to leave it in the fluid state at common barometric pressure. It was, however, rapidly dissipated, not producing visible fumes, but producing the odour of pure sulphurous acid, and leaving the tube quite dry. A portion of the vapour of the fluid received over a mercurial bath, and examined, proved to be sulphurous acid gas. A piece of ice dropped into the fluid instantly made it boil, from the heat communicated by it.

To prove in an unexceptionable manner that the fluid was pure sulphurous acid, some sulphurous acid gas was carefully prepared over mercury, and a long tube perfectly dry, and closed at one end, being exhausted, was filled with it: more sulphurous acid was then thrown in by a condensing syringe, till there were three or four atmospheres; the tube remained perfectly clear and dry, but on cooling one end to 0°, the fluid sulphurous acid condensed, and in all its characters was like that prepared by the former process.

Sulphurous acid vapour exerts a pressure of about two atmospheres at 45° F. Its specific gravity was nearly 1.42.

Sulphuretted Hydrogen. — A tube being bent, and sealed at the shorter end, strong muriatic acid was poured in through a small funnel, so as nearly to fill the short leg without soiling the long one. A piece of platinum foil was then crumpled up and pushed in, and upon that were put fragments of sulphuret of iron, until the tube was nearly full. In this way action was prevented until the tube was sealed. If it once commences, it is almost impossible to close the tube in a manner sufficiently strong, because of the pressing out of the gas. When closed, the muriatic acid was made to run on to the sulphuret of iron, and then left for a day or two. At the end of that time, much protomuriate of iron had formed, and on placing the clean end of the tube in a mixture of ice and salt, warming the other end, if necessary, by a little water, sulphuretted hydrogen in the liquid state distilled over.

The liquid sulphuretted hydrogen was colourless, limpid,

and excessively fluid. It did not mix with the rest of the fluid in the tube, which was no doubt saturated, but remained standing on it. When a tube containing it was opened, the liquid immediately rushed into vapour; and this being done under water, and the vapour collected and examined, it proved to be sulphuretted hydrogen gas. As the temperature of a tube containing some of it rose from 0° to 45°, part of the fluid rose in vapour, and its bulk diminished; but there was no other change: it did not seem more adhesive at 0° than at 45°. Its refractive power appeared to be rather greater than that of water: it decidedly surpassed that of sulphurous acid. The pressure of its vapour was nearly equal to 17 atmospheres at the temperature of 50°.

The specific gravity of sulphuretted hydrogen appeared to be 0.9.

Carbonic Acid. — The materials used in the production of carbonic acid, were carbonate of ammonia and concentrated sulphuric acid; the manipulation was like that described for sulphuretted hydrogen. Much stronger tubes are, however, required for carbonic acid than for any of the former substances, and there is none which has produced so many or more powerful explosions. Tubes which have held fluid carbonic acid well for two or three weeks together, have, upon some increase in the warmth of the weather, spontaneously exploded with great violence; and the precautions of glass masks, goggles, &c. which are at all times necessary in pursuing these experiments, are particularly so with carbonic acid.

Carbonic acid is a limpid colourless body, extremely fluid, and floating upon the other contents of the tube. It distils readily and rapidly at the difference of temperature between 32° and 0°. Its refractive power is much less than that of water. No diminution of temperature to which I have been able to submit it, has altered its appearance. In endeavouring to open the tubes at one end, they have uniformly burst into fragments, with powerful explosions.

Its vapour exerted a pressure of 36 atmospheres, at a temperature of 32°.

Euchlorine. — Fluid euchlorine was obtained by inclosing chlorate of potash and sulphuric acid in a tube, and leaving them to act on each other for 24 hours. In that time there had been much action, the mixture was of a dark reddish-brown, and the atmosphere of a bright yellow colour. The mixture was then heated up to 100°, and the unoccupied

end of the tube cooled to 0°; by degrees the mixture lost its dark colour, and a very fluid ethereal looking substance condensed. It was not miscible with a small portion of the sulphuric acid which lay beneath it; but when returned on to the mass of salt and acid, it was gradually absorbed, rendering the mixture of a much deeper colour even than itself.

Euchlorine thus obtained is a very fluid transparent substance, of a deep yellow colour. A tube containing a portion of it in the clean end, was opened at the opposite extremity; there was a rush of euchlorine vapour, but the salt plugged up the aperture: whilst clearing this away, the whole tube burst with a violent explosion, except the small end in a cloth in my hand; where the euchlorine previously lay, but the fluid had all disappeared.

Nitrous Oxide. — Some nitrate of ammonia, previously made as dry as could be by partial decomposition, by heat in the air, was sealed up in a bent tube, and then heated in one end, the other being preserved cool. By repeating the distillation once or twice in this way, it was found, on after-examination, that very little of the salt remained undecomposed. The process requires care. I have had many explosions occur with very strong tubes, and at considerable risk.

When the tube is cooled, it is found to contain two fluids, and a very compressed atmosphere. The heavier fluid, on examination, proved to be water, with a little acid and nitrous oxide in solution; the other was nitrous oxide. It appears in a very liquid, limpid, colourless state; and so volatile, that the warmth of the hand generally makes it disappear in vapour. The application of ice and salt condenses abundance of it into the liquid state again. It boils readily by the difference of temperature between 50° and 0°. It does not appear to have any tendency to solidify at — 10°. Its refractive power is very much less than that of water, and less than any fluid that has yet been obtained in these experiments, or than any known fluid. A tube being opened in the air, the nitrous oxide immediately bursts into vapour.

The pressure of its vapour is equal to above 50 atmospheres at 45°.

Cyanogen. — Some pure cyanuret of mercury was heated until perfectly dry. A portion was then enclosed in a green glass tube, in the same manner as in the former instances, and being collected to one end, was decomposed by heat, whilst the other end was cooled. The cyanogen soon appeared as a liquid: it was limpid, colourless, and very fluid

not altering its state at the temperature of 0°. Its refractive power is rather less, perhaps, than that of water. A tube containing it being opened in the air, the expansion within did not appear to be very great; and the liquid passed with comparative slowness into the state of vapour, producing great cold. The vapour, being collected over mercury, proved to be pure cyanogen.

A tube was sealed up with cyanuret of mercury at one end, and a drop of water at the other; the fluid cyanogen was then produced in contact with the water. It did not mix, at least in any considerable quantity, with that fluid, but floated on it, being lighter, though apparently not so much so as ether would be. In the course of some days, action had taken place, the water had become black, and changes, probably such as are known to take place in an aqueous solution of cyanogen, occurred. The pressure of the vapour of cyanogen appeared to be 2.6 or 3.7 atmospheres at 45° Fahr. Its specific gravity was nearly 0.9.

Ammonia.—When dry chloride of silver is put into ammoniacal gas, as dry as it can be made, it absorbs a large quantity of it; 100 grains condensing above 130 cubical inches of the gas: but the compound thus formed is decomposed by a temperature of 100° Fahr. or upwards. A portion of this compound was sealed up in a bent tube, and heated in one leg, whilst the other was cooled by ice or water. The compound thus heated under pressure, fused at a comparatively low temperature, and boiled up, giving off ammoniacal gas, which condensed at the opposite end into a liquid.

Liquid ammonia thus obtained was colourless, transparent, and very fluid. Its refractive power surpassed that of any other of the fluids described, and that also of water itself. When the chloride of silver is allowed to cool, the ammonia immediately returns to it, combining with it, and producing the original compound. During this action a curious combination of effects takes place: as the chloride absorbs the ammonia, heat is produced, the temperature rising up nearly to 100°; whilst a few inches off, at the opposite end of the tube, considerable cold is produced by the evaporation of the fluid. When the whole is retained at the temperature of 60°, the ammonia boils till it is dissipated and re-combined. The pressure of the vapour of ammonia is equal to about 6.5 atmospheres at 50°. Its specific gravity was 0.76.

Muriatic Acid.— When made from pure muriate of ammonia and sulphuric acid, liquid muriatic acid is obtained colourless, as Sir Humphry Davy had anticipated. Its re-

fractive power is greater than that of nitrous oxide, but less than that of water; it is nearly equal to that of carbonic acid. The pressure of its vapour at the temperature of 50° is equal to about 40 atmospheres.

Chlorine. — The refractive power of fluid chlorine is rather less than that of water. The pressure of its water at 60° is nearly equal to four atmospheres.

Mr. Faraday made many similar experiments on other gases, though he could not succeed in condensing any others than those mentioned.

Observations on the Migration of Birds. By Edward Jenner, *M.D. Communicated by the Rev. G. C.* Jenner.

It is not my intention, in the following pages, to give a general history of the migration of birds. The order in which they appear and disappear, their respective habits, and many other observations, have been given with considerable accuracy by several naturalists, who have paid attention to this very curious subject. It is with a view of representing some facts, hitherto unnoticed, chiefly with respect to the *cause*, which excites the bird, at certain seasons of the year, to quit one country for another, that I communicate the following pages to this learned body.

But before I proceed to state my observations on this head, it may be necessary to adduce some arguments, first, in support of the reality of migration, the fact itself not being generally admitted; and, secondly, against the hypothesis of a state of torpor, or what has been called the hibernating system.

In the first place, the ability of birds to take immensely long flights is proved by the observations of almost every person conversant with the seas. To the many instances already recorded, I shall add the following: —

My late nephew, Lieutenant Jenner, on his passage to Newfoundland, saw, on the 20th of May, the hobby hawk. It came on board, and was secured. The day following a swallow came on board. At this time the ship was steering a course direct for that island, and was not within the distance of a hundred leagues of any land. His brother, the Rev. G. C. Jenner, in crossing the Atlantic, observed an owl (of what species he could not precisely ascertain, but he believes it to be the common brown owl,) gliding over the ocean with as much apparent ease as if it had been seeking for a mouse among its native fields. Wild geese have fre-

quently been shot in Newfoundland, whose crops were plentifully stored with maize, or Indian corn; consequently, these birds must have taken a pretty bold flight in a short space of time, as no corn of this kind is cultivated within a vast distance of that island. These, however, I do not consider as migrations of any farther consequence, than just to show the powers of the wing.

My ingenious friend and neighbour, the late Rev. Nath. Thornbury, who had occasionally visited Holland, informed me, that the pigeons about the Hague make a daily marauding excursion, at certain seasons, to the opposite shore of Norfolk, to feed on vetches, a distance of forty leagues. Now, may not this be almost considered as daring a flight as that of the bird which crosses the Atlantic? For it is not at all probable that the shores of this country can be visible to the flock when they set out.

Again. Is there not something as extraordinary in the pigeon, which can, in a few hours, find out its home, though taken away in a box and totally excluded from the light, to the distance of 200 miles, as in that bird which quits one shore to seek another, whatever may be the extent of intervening seas? The fact seems to be, that we, the *little lords of the creation*, are too prone to measure the sentient principle in animals by the scale of our own ideas, and thus, unwillingly, allow them to possess faculties which may surpass our own, though peculiarly appropriate to their respective natures; but a little reflection must compel us to confess, that they are endowed with discriminating powers totally unknown to, and for ever unattainable by man. I have no objection to admit the possibility that birds may be overtaken by the cold of winter, and thus be thrown into the situation of other animals which remain torpid at that season; though I must own I never witnessed the fact, nor could I ever obtain evidence on the subject that was to me satisfactory: but as it has been often asserted, may I be allowed to suppose, that some deception might have been practised with the design of misleading those to whom it might seem to have appeared obvious? For far be it from me to insinuate that the subject has been wilfully misrepresented by those naturalists who have stated it as a fact. Yet how careful should we be in the investigation of all subjects in natural history, which may captivate, by their apparent novelty!

If birds crept into holes and crevices to hibernate, would they not, like quadrupeds, creep out again in a languid state, their fat all absorbed, and their bodies emaciated? We see

this fact exemplified in the hedge-hog, one of the most remarkable of our hibernating animals, which retires to its hut at the approach of winter, with vast stores of fat placed in every situation where nature could find room for it. This fat is its only source of nutrition for the winter, which, by the time the sun rouses it to fresh life and activity, is exhausted, and the animal comes forth thin and emaciated. But the case with birds is extremely different. If, on the first day of its appearance, a martin, a swift, or a redstart be examined, it will be found as plump and fleshy as at any season during its stay; it appears also as strong on the wing, and as full of activity at that period as at any other during its abode with us. How the cuckoo that disappears at so early and so hot a season as the first week in July, can become torpid, is beyond the power of conception.

The apparent incapability of the landrail to perform the task of migration has often been so strongly adduced as a presumptive argument in favour of the hibernating system, that those who do not admit that of migration, were it to remain unnoticed, might urge it as an objection. It must be admitted, that a superficial examination of the habits of this bird tends to favour the supposition of its incapacity for so great an exploit, as it often rises from the ground like a half animated lump, and seems, with difficulty, to take a flight of a hundred yards; but let us remark its powers when seriously alarmed. Should it be forced upon the wing by any extraordinary cause, by the pursuit of a hawk, for example, the velocity of its flight, and the rapidity of its evolutions to avoid the common enemy of its race, will at once appear. This is no very rare exhibition. Necessity here, as in migration, becomes the parent of exertion, which, when thus called forth, cannot be shown in a much greater degree by any of the feathered tribe. The moor-hen (which winters with us) gives another instance of what a bird, which appears so much to want activity in its ordinary flights, is capable of performing when exertion is actually required. When pursued by a hawk, and self-preservation calls up all its powers, it may be seen to rush up into the air with amazing velocity, almost as high as the eye can reach, then darting down with an equal pace, it often, by such rapid manœuvres, escapes the destructive talons of its swift pursuer.

It is a remarkable fact that the swallow tribe, and probably many other birds which absent themselves at stated periods, should return annually to the same spot to build their nests. The swift, which for nine months has some distant

region to roam in, was selected for the purpose of an experiment to assertain this with precision. At a farm-house in this neighbourhood, I procured several swifts, and by taking off two claws from the foot of twelve, I fixed upon them an indelible mark. The year following their nesting places were examined in an evening when they had retired to roost, and there I found several of the marked birds. The second and third year a similar search was made, and did not fail to produce some of those which were marked. I now ceased to make an annual search; but at the expiration of seven years, a cat was seen to bring a bird into the farmer's kitchen, and this also proved to be one of those marked for the experiment.

That the bird, when the stimulus for migration is given, with the choice before it of almost any part of Europe for its annual excursion, should so uniformly not only revisit this island, but even select the same spot for its breeding place, is certainly a wonderful occurrence. But if birds were not instinctively directed to return to their old haunts, should we not find them over crowding some situations, while others would be left desolate? And would not this be the case if the search of food was the object of their migration? However it may be admissible, in one point of view, to consider the bird in its state of migration from this country, as a nearer neighbour than at first might be conceived, if we may be allowed to consider distance or space in the instance before us, as governed by the power of progressive motion, of what consequence is it to the swift, which, to use the animated expression of Mr. White, "dashes through the air with the inconceivable swiftness of a meteor," whether he comes to us from some neighbouring country, or the shores of Africa? The wonder excited by the return of these birds again to their old nesting places would at once cease, if we could believe what has been asserted by some naturalists, and gained credit with many, namely, that at the time they disappear from us, they submerse themselves in ponds and rivers, and in this situation become torpid. If this idea had not been encouraged and supported by some new hypothesis, I should hardly have thought it necessary to have taken any serious notice of it; but as the matter now stands, I will just state my opinion, why I think it impossible for any birds to be disposed of in this way.

Permit me first to call to your recollection the season of the year at which many of these birds disappear. It happens when they feel no cold blast to benumb them, and when the

common food with which they are supported is distributed through the air in the greatest abundance. At such a time, what can be the inducement to them and their young ones, which have but just begun to enjoy the motion of their wings, and play among the sun-beams, to take this dreary plunge? And how is the office of respiration to be performed during the nine months' watery residence? The structure of the lungs of birds differs not essentially from that of quadrupeds, and therefore all communication with the atmosphere being cut off from the first moment of submersion, the possibility of a bird living nine months, or indeed as many minutes, under water, appears to be totally irreconcilable with the nature of their structure. I have taken a swift about the 10th of August, which may be considered as the eve of its departure, and plunged it into water; but like the generality of animals which respire atmospheric air, it was dead in two minutes.

At the coming on of spring we observe our more domestic birds, those that approach our houses, and are most familiar to us, assuming new habits. The voice, gesticulation, and the attachment which the male begins to show to the female, plainly indicate some new agency acting upon the constitution. This newly excited influence, which so conspicuously alters the habits of our birds at home, is, at the same time, exerting itself abroad upon those which are destined to resort hither. It is the preparation which nature is making for the production of an offspring by a new arrangement in the structure of their organs.

No sooner is the impulse arising from this change sufficiently felt, than the birds are directed to seek a country where they can for a while be better accommodated with succours for their infant brood than in that from which they depart.

The business of nesting then begins; and as a convincing proof that nesting is the chief cause of their errand here, this, and its natural consequences, occupy their attention from the time of their coming to the day of their departure. This is illustrated by the despatch which some of them make in performing the object of their mission. The cuckoo finishes this business in a shorter space of time than any other bird; but as he deviates so widely from the common laws of the feathered society, I shall select the swift, as a better example for pointing out the fact. The swift shows himself here about the beginning of May (sometimes a few stragglers appear earlier), and by the beginning of August

he has completely reared his young ones, which seldom consist of more than two. At once the old birds and their family take their leave, and are seen no more for that season. Now his farther residence cannot be rendered unpleasant by any disagreeable change in the temperature of the air, or from a scarcity of his common food, which at this time abounds in the greatest plenty.

Now, should the principle I have laid down be admitted, namely, that these birds come here for scarcely any other purpose than to produce an offspring, and retreat when the task is finished, how easily will all circumstances be reconciled? and how little mysterious will those things appear which naturally seemed unaccountable to those who have written before on the same subject.

The spring migrating birds do not arrive here at first in very large numbers. It may be observed, that in the early part of April a few swallows may be seen; soon after these a few solitary martins, and as the month advances now and then a swift. On the walls of Berkeley Castle, martins build their nests in great numbers. I availed myself of their situation, and took several of them on the same night, the latter end of May. On dissection, the cause of their gradual and successive migrations appeared obvious, the ovaria being in very different states of progressive forwardness. While one bird presented embryo eggs in the ovarium as large as peas, in another they were found no larger than hemp-seed. These were the extremes; for in the other birds there appeared all the intermediate stages, from the enlargement of the ovaria, sufficient to give the stimulus for migration, to the degree of forwardness just described. The same gradations in the state of the male corresponded with that of the ovaria in the females. This progressive arrival is not confined to the swallow tribe: all the birds that come early in the spring appear in the same gradual manner. I cannot help observing, that here the wise design of Providence is very conspicuous. Their appearance keeps pace with that of the insects which are to afford them food. If the numbers which flock in upon us in May were to arrive in April, when only part of them appear, all must be insufficiently supplied, and many of course perish from a want of the needful succours; but by the middle of May, myriads of insects have produced eggs, and great numbers have either brought forth, or matured their progeny; and it may be remarked, there is still a greater increase of insect food by the time the young birds begin to require it. Swallows, on their first coming, feed

principally upon gnats. These insects are called forth from their wintry retreats when the air is but moderately heated, 48 degrees of Fahrenheit's thermometer being sufficient to put them on the wing. It is in pursuit of them that we see, in cool weather, the swallow incessantly skimming over the surface of ponds and brooks; and their thus early hovering over water has strengthened the idea of their having lately emerged from their watery abode, where they are supposed to have lain dormant during the winter. But they are driven by necessity to feed on the gnat. Like the swift and martin, their more favourite food is a small beetle of the scarabæus kind, which, on dissection, I have found in far greater abundance in their stomachs than any other insects.

The state of the female and male, which I have alluded to, sometimes comes on prematurely, and in the same manner sometimes subsides. When this happens, swallows and martins desert their nestlings, and leave them to perish in the nest. The economy of the animal seems to be regulated by some external impulse, which leads to a train of consequences. When this change takes place, the bird becomes impelled by a stronger principle, that is, the desire of self-preservation. This sometimes happens when they produce a very late hatch. A pair of martins hatched four broods of young ones in the house of a tradesman in this place, in the year 1786. The latter brood was hatched in the early part of October. About the middle of the month the old birds went off, and left their young ones, about half fledged, to perish. The pair returned to the nest, the 17th of May, 1787, and threw the skeletons out.

Thus scarcely a winter passes but we hear of a nest of robins, hedge-sparrows, and some others of the smaller birds. We have been informed by Pennant, and it has been noticed also by others, that the cuckoo has been heard to give his song so early as the middle of February, two months sooner than the usual time. The same deviation from the ordinary course of nature, which prematurely occasions the pairing of our domestic birds above mentioned, proves the stimulus, I conceive, to certain unseasonable migrations, and accounts for the irregularity first noticed. The same argument is of course applicable to the premature appearance of any other migrating birds. The month of March sometimes affords us warm weather for several successive days. At this time I have often seen the snake basking under a hedge. The lizard, too, has been invited from his cold retreat; but never could I see the swallow or the martin, although I have taken

every opportunity of looking for them during the transient sunshine, and made diligent enquiries of others. At the further advancement of spring, often in April, when, from the long prevalence of north-easterly winds, the weather becomes unseasonably cold, and even frosty, swallows, martins, and other early migrators, appear among us. But they soon experience the hardships of an inhospitable reception: the insects that should afford them food being still in a state of torpor in their winter recesses, and unless called forth by some agreeable change in the air, the unfortunate birds perish for want of food. This I have known happen during an inclement spring, and have picked up starved martins under their nesting places, and willow wrens, which have perished under hedges, through a want of succours.

Unlike the migrating birds that winter with us, of which I shall speak in a subsequent part of this paper, the spring or summer birds do not possess the disposition to change the scene and seek a more genial clime, when this country is so overspread by frost as to deny them their common supplies. This, I imagine, will admit of an easy explanation. The winter birds require nothing here but food and shelter. Our summer visitors come for more various and important purposes. Had they, like the former birds, been endowed with a disposition to wander on certain changes of the atmosphere, the great design of their migration, as it must have proved fatal to the business of incubation and the rearing of their young, would have been frustrated. It may be worthy of remark, that both the summer and winter migrating birds are, on their arrival here, well received by the domestic natives, and neither create quarrels nor excite fears. The redstart builds its nest in the same tree with the titmouse, and the redwing feeds peaceably in the same meadow with the starling.

I proceed now to make some observations on another kind of migration, directly opposite to the foregoing, namely, the return of the spring migrators to their respective *homes*.

The great disproportion in numbers between those species of birds which quit the country in summer, and those that leave it at the autumnal season, has led naturalists to lose sight of the early migrators, and to confine their reflections on the subject to the later ones only. Hence the common observation, that they are *all* driven off through a failure of food, or a cold temperature of the air. But seeing that many of them disappear in the summer season, when food is placed before them in the greatest plenty, we must seek for some

other cause. If we examine what is now going forward in the animal economy, dissection will point out a change in the organs of the bird, the very opposite to that which took place in the spring. These parts now begin to shrink, the disposition for raising a farther progeny ceases, and the nuptial knot is dissolved. What inducement have they to stay longer in that country, where, I think, it clearly appears their chief object is to multiply their species? This being now effected, they retire to different parts of the globe, doubtless better suited to their general dispositions and wants, when disengaged from parental duties. In many of the migrating species, indeed in the far greater number, the disposition for farther incubation, and the season for their procuring a farther supply of insect food, cease at the same time. It is pretty evident from the habits of the cuckoo and the swift, that quit us in the summer as soon as their nesting is at an end, that swallows, martins, and those birds that disappear in the autumn, would depart at an earlier season, even though their supplies were to continue, if the rearing of their young were perfected. Indeed, as has been before observed, so strong does this propensity now and then appear, that it overcomes even the obligation of rearing their young when hatched late in the season, and they are sometimes left in a callow state to perish in their nests. This premature departure probably arises from a reverse of that stimulus which occasions the too early migration of the spring birds, as has been noticed in a former part of this essay, namely, a change which takes place in their organisation.

One of the most singular occurrences in the history of migration is the mode of departure of the young birds from the country where they were produced. It may be conceived that the bird which had once crossed the Atlantic, or any other ocean, might have something impressed upon it that should prove an inducement to its return; but this cannot be an incitement to the young one. The identical bird, which but a few weeks before burst from the shell, now unerringly finds, without any apparent guide, a track that leads it safely to the place of its destination, perhaps, in many instances, over the widest oceans.

It is well known, that those birds which incubate several times in the course of one summer forsake their first broods when they no longer require their protection; and being now alienated, they cannot, in their parents, find the guides that conduct their course. As swallows and martins congregate previous to their departure from us, it may be said that their

young, though discarded, may mingle with the common flock; and in this particular instance I am ready to admit that it is probable they may do so: but there are many migrating birds that never either associate with swallows and martins, or join together in flocks, as the nightingale, redstart, and indeed the far greater number. As a striking proof that the parent bird cannot possibly be the guide, in one instance at least, we may point out the cuckoo, whose offspring finds a distant shore in perfect safety, although it could never know the parent to whom it was indebted for existence, and though its existence, in numberless instances, must have taken place even after the departure of the parent. For the old cuckoos invariably leave us early in July, when many of their eggs are yet unhatched in the nests of those small birds to whose fostering care they are entrusted. Compared with quadrupeds, and some other animals, birds may be considered as acquiring the adult state at an early period, and the young bird, at the time of its leaving us, may be looked upon as possessing power equal to the old one in procuring food, velocity of flight, &c. The parent bird, from having lost that stimulus by the subsiding of that state of its organs, which urged it to incubation and detained it here, is now reduced to a condition similar to that of its offspring, both falling into the same habits, and remaining in the same state with respect to organisation, until the returning calls of nature urge them to quit that country again to which they are *now* about to depart.

The winter birds of passage, as they are commonly called, begin to take their leave of us about the same time that the spring migrators are taking wing to pay us their annual visit. As the latter appear among us in gradual succession, so in like manner the former disappear. They are both actuated by the same impulse, the former in leaving, and the latter in coming to this country. As soon as the stimulus becomes sufficiently felt, they quit their homes in quest of a country better suited to their intended purpose than their own.

That a want of food cannot be the inducement, must be obvious to the slightest observer. When the redwing and fieldfare quit this country, it abounds with that food which they prefer to any other; and at this time they are in the finest condition; the redwings often enjoying their plenty by assembling together on trees, and there uniting their feeble voices. make no unpleasant song.

The migration of the winter birds is less distinctly marked than that of the spring migrators. The snipe, the wild-

duck, and the wood-pigeon, breed here in considerable numbers; the two latter, indeed, particularly the wood-pigeon, are so numerous in summer, that we should hardly be reminded of the migration, did they not pour in upon us in such immense flocks in the winter. They are accompanied by the stock-dove, which I have never known to breed here. The home-bred wild-ducks are easily distinguished by the men who attend decoy-pools, by the meanness of their plumage, when compared to the brightness of those birds which come from abroad. The former are taken some weeks earlier than the latter.

The most conspicuous among the winter migrating birds are the redwings and fieldfares. These are regular and uniform in their appearance and disappearance, and I believe never risk the trial of incubation here, at least I never could hear of a single instance. The food of these birds has in the works of every naturalist I have ever had access to, who had written on the subject, been pointed out as the haw, the fruit of the white thorn.

This is an error that has long wanted a correction; for in open weather they take them in very scanty quantities, and feed on the ground on worms and such insects as they can find. Although repeated examinations of the contents of the stomach have afforded the best proof of this, yet there is scarcely any need of calling in its aid in the present instance, as we may be convinced of the fact, by seeing them in flocks feeding on the ground in open fields and meadows. I do not deny their taking the haw and other vegetable food from the hedges, but they do it in so sparing a way, that I have remarked, that redwings and fieldfares die through hunger during the long continuance of frosty weather, while the haws on the hedges were by no means deficient. The occasional departure of these and some other winter birds during a long continued frost must be very obvious. The greater number disappear soon after its commencement, if it sets in very severely: some few are always left behind, and are soon starved, if not fortunately relieved by a thaw. Those that are driven to this necessitous migration probably pursue a track that quickly leads them out of the reach of frost. Of these flights I shall produce instances, which render it probable that they are able even to outstrip its course.

The approach of intense frost is often, to a certainty, made known to us, by the appearance of a numerous tribe of water birds, some of which are rare, and seldom show themselves here on any other occasion. We commonly see them three

or four days prior to the setting in of very severe frosty weather. This was manifest at the latter end of the year 1794, at the coming on of the severe season that ensued. In the river Severn, about a mile and a half to the westward of this place, were seen and taken many species of water-birds, that generally confine themselves to the more northern regions. Far more pleasant is it to see during the continuance of hard frost, the return of those birds which had left us at the beginning. These are pleasant omens, and most certainly forbode a thaw.

To recapitulate the substance of my observations. I have first adduced some arguments in support of migration, the fact itself not being generally admitted by naturalists of celebrity, and also against the hypothesis of a state of torpor, or what may be termed the hibernating system. I have represented that the swallow tribe, and many other birds that absent themselves at stated periods, return annually to the same spot to build their nests; and at the same time that any inference drawn from this fact in support of a state of torpor would be fallacious upon physiological principles. That certain periodical changes of their organs are the inciting causes of migration I have stated many facts, hitherto, I believe, unnoticed, chiefly with respect to the *cause* which excites the migrating bird, at certain seasons of the year, to quit one country for another, and the need of a country where they can for a while be better accommodated with succours for their infant brood than in that from which they depart. It is also attempted to be shown, that their departure from this country is not in consequence of any disagreeable change in the temperature of the air, or from a scarcity of their common food, but the result of the accomplishment of their errand, *i. e.* the incubation, and rearing of their young. That successive arrivals of migrating birds are attributable to the progressive developement already noticed in the male and female; that progressive developements are wise provisions of nature; that premature arrivals and departures are frequently to be accounted for on the same principle.

With respect to the winter birds of passage, I have stated that they quit their homes (this country) in spring, in quest of a country better suited to their intended purpose than their own; that they are actuated by the same impulse in quitting this country that causes the spring birds to come to it; and that want of food cannot be the inducement; that the emigration of the winter birds is less complete than that of the others (the spring migrators); that some species breed

here, especially the wild-duck and wood-pigeon; that the redwings and fieldfares are the most regular and uniform in their appearance and disappearance, and, most probably, never risk the trial of incubation here; that they quit the country *temporarily* in severe and long continued frost through want of food, and return to it again at the approach of more temperate weather; that the arrival of water birds forebodes the approach of intense frost, the usual return of the winter birds, a thaw; that examinations of the latter prove them to have taken long flights before their return, and sets the fact of temporary migration beyond the reach of doubt.

On the Corrosion of Copper Sheeting by Sea Water, and on Methods of preventing this Effect; and on their Application to Ships of War and other Ships. By Sir HUMPHRY DAVY, *Bart. President of the Royal Society.*

THE attention of Sir Humphry Davy having been directed to the rapid decay of the sheeting of our ships of war, by the Commissioners of the Navy Board, he commenced his investigation of this subject by some experiments on the causes of the action of sea water on copper.

When a piece of polished copper is suffered to remain in sea water, the first effects observed are, a yellow tarnish upon the copper, and a cloudiness in the water, which take place in two or three hours: the hue of the cloudiness is at first white; it gradually becomes green. In less than a day a bluish-green precipitate appears in the bottom of the vessel, which constantly accumulates; at the same time that the surface of the copper corrodes, appearing red in the water, and grass-green where it is in contact with air. Gradually carbonate of soda forms upon this grass-green matter; and these changes continue till the water becomes much less saline.

The green precipitate, when examined by the action of solution of ammonia and other tests, appears principally to consist of an insoluble compound of copper (which may be considered as a hydrated sub-muriate) and hydrate of magnesia.

On pursuing his enquiry with various specimens of copper, taken from different ships, some of which had been considered as remarkable for their durability, and others for their rapid decay,—which difference some persons had supposed to result from the different states of the metal in regard to purity,—he found, that although differently alloyed, they offered but very inconsiderable differences in their action on sea water, and, consequently, he inferred that the changes

they had undergone must have depended on other causes than the relative purity of the metal. Sir Humphry Davy had, as early as the year 1806, advanced the hypothesis, that chemical and electrical changes may be identical, or dependent on the same property of matter. He also showed that chemical attractions may be exalted, modified, or destroyed by changes in the electrical states of bodies; that substances will combine only when they are in different electrical states; and that, by bringing a body naturally positive, artificially into a negative state, its usual powers of combination are altogether destroyed. By reasoning on this hypothesis, he was led to the discovery which is the subject of this paper.

He says, "Copper is a metal only weakly positive in the electro-chemical scale; and, according to my ideas, it could only act upon sea water when in a positive state; and, consequently, if it could be rendered slightly negative, the corroding action of sea water upon it would be null; and whatever might be the differences of the kinds of copper sheeting and their electrical action upon each other, still every effect of chemical action must be prevented, if the whole surface were rendered negative. But how was this to be effected? I at first thought of using a Voltaic battery; but this could be hardly applicable in practice. I next thought of the contact of zinc, tin, or iron: but I was for some time prevented from trying this, by the recollection that the copper in the Voltaic battery, as well as the zinc, is dissolved by the action of diluted nitric acid; and by the fear that too large a mass of oxidable metal would be required to produce decisive results. After reflecting, however, for some time on the slow and weak action of sea water on copper, and the small difference which must exist between their electrical powers, and knowing that a very feeble chemical action would be destroyed by a very feeble electrical force, I resolved to try some experiments on the subject. I began with an extreme case. I rendered sea water slightly acidulous by sulphuric acid, and plunged into it a polished piece of copper, to which a piece of tin was soldered equal to about one twentieth of the surface of the copper. Examined after three days the copper remained perfectly clean, whilst the tin was rapidly corroded: no blueness appeared in this liquor; though, in a comparative experiment, when copper alone and the same fluid mixture was used, there was a considerable corrosion of the copper, and a distinct blue tint in the liquid.

"If one twentieth part of the surface of tin prevented the action of sea water, rendered slightly acidulous by sulphuric

acid, I had no doubt that a much smaller quantity would render the action of sea water, which depended only upon the loosely attached oxygen of common air, perfectly null; and on trying $\frac{1}{200}$ part of tin, I found the effect of its preventing the corrosion of the copper perfectly decisive.

"This general result being obtained, I immediately instituted a number of experiments, in most of which I was assisted by Mr. Faraday, to ascertain all the circumstances connected with the preservation of copper by a more oxidable metal. I found, that whether the tin was placed either in the middle, or at the top, or at the bottom of the sheet of copper, its effects were the same; but, after a week or ten days, it was found that the defensive action of the tin was injured, a coating of submuriate having formed, which preserved the tin from the action of the liquid.

"With zinc or iron, whether malleable or cast, no such diminution of effect was produced. The zinc occasioned only a white cloud in the sea water, which speedily sunk to the bottom of the vessel in which the experiment was made. The iron occasioned a deep orange precipitate: but after many weeks, not the smallest portion of copper was found in the water; and so far from its surface being corroded, in many parts there was a regeneration of zinc or of iron found upon it.

"In pursuing these researches, and applying them to every possible form and connection of sheet copper, the results were of the most satisfactory kind. A piece of zinc as large as a pea, or the point of a small iron nail, were found fully adequate to preserve 40 or 50 square inches of copper; and this, wherever it was placed, whether at the top, bottom, or in the middle of the sheet of copper, and whether the copper was straight or bent, or made into coils. And where the connection between different pieces of copper was completed by wires, or thin filaments of the fortieth or fiftieth of an inch in diameter, the effect was the same; every side, every surface, every particle of the copper remained bright, whilst the iron or the zinc was slowly corroded.

"A piece of thick sheet copper, containing on both sides about 60 square inches, was cut in such a manner as to form seven divisions, connected only by the smallest filaments that could be left, and a mass of zinc, of the fifth of an inch in diameter, was soldered to the upper division. The whole was plunged under sea water; the copper remained perfectly polished. The same experiment was made with iron: and now, after a lapse of a month, in both instances, the copper is as bright as when it was first introduced, whilst similar

pieces of copper, undefended, in the same sea water, have undergone considerable corrosion, and produced a large quantity of green deposit in the bottom of the vessel.

"A piece of iron nail about an inch long, was fastened by a piece of copper wire, nearly a foot long, to a mass of sheet copper, containing about 40 square inches, and the whole plunged below the surface of sea water: it was found, after a week, that the copper was defended by the iron in the same manner as if it had been in immediate contact.

"A piece of copper and a piece of zinc soldered together at one of their extremities, were made to form an arc in two different vessels of sea water; and the two portions of water were connected together by a small mass of tow moistened in the same water: the effect of the preservation of the copper took place in the same manner as if they had been in the same vessel.

"As the ocean may be considered, in its relation to the quantity of copper in a ship, as an infinitely extended conductor, I endeavoured to ascertain whether this circumstance would influence the results; by placing two very fine copper wires, one undefended, the other defended by a particle of zinc, in a very large vessel of sea-water, which water might be considered to bear the same relation to so minute a portion of metal as the sea to the metallic sheeting of a ship. The result of this experiment was the same as that of all the others; the defended copper underwent no change; the undefended tarnished, and deposited a green powder.

"Small pieces of zinc were soldered to different parts of a large plate of copper, and the whole plunged in sea water: it was found that the copper was preserved in the same manner as if a single piece had been used.

"A small piece of zinc was fastened to the top of a plate of polished copper, and a piece of iron of a much larger size was soldered to the bottom, and the combination placed in sea water. Not only was the copper preserved on both sides in the same manner as in the other experiments, but even the iron; and after a fortnight, both the polish of the copper and the iron remained unimpaired."

Additional Experiments and Observations on the Application of Electrical Combinations to the Preservation of the Copper Sheathing of Ships, and to other Purposes. By Sir HUMPHRY DAVY, *Bart.*

SIR HUMPHRY DAVY, in this paper, presents the results of his progressive experiments, made in our naval establish-

ments at Chatham and Portsmouth. These results are conformable with his original theoretical views.

"Sheets of copper, defended by from $\frac{1}{40}$ to $\frac{1}{1000}$ part of their surface of zinc, malleable and cast iron, were exposed, for many weeks, in the flow of the tide in Portsmouth harbour, and their weights ascertained before and after the experiment. When the metallic protector was from $\frac{1}{40}$ to $\frac{1}{150}$, there was no corrosion nor decay of the copper; with smaller quantities, such as from $\frac{1}{200}$ to $\frac{1}{400}$, the copper underwent a loss of weight, which was greater in proportion as the protector was smaller; and as a proof of the universality of the principle, it was found that even $\frac{1}{1000}$ part of cast iron saved a certain proportion of the copper.

"The sheeting of boats and ships, protected by the contact of zinc, cast and malleable iron in different proportions, compared with those of similar boats and sides of ships unprotected, exhibited bright surfaces, whilst the unprotected copper underwent rapid corrosion, becoming first red, then green, and losing a part of its substance in scales.

"Fortunately, in the course of these experiments, it has been proved that cast iron, the substance which is cheapest and most easily procured, is likewise most fitted for the protection of the copper. It lasts longer than malleable iron, or zinc; and the plumbaginous substance, which is left by the action of sea water upon it, retains the original form of the iron, and does not impede the electrical action of the remaining metal.

"I had anticipated the deposition of alkaline substances in certain cases upon the negatively electrical copper. This has actually happened. Some sheets of copper, that have been exposed nearly four months to the action of sea water, defended by from $\frac{1}{35}$ to $\frac{1}{80}$ of their surface of zinc and iron, have become coated with a white matter, which, on analysis, has proved to be principally carbonated lime, and carbonate and hydrate of magnesia. The same thing has occurred with two harbour boats, one of which was defended by a band of zinc, the other by a band of iron, equal to about $\frac{1}{35}$ of the surface of the copper.

"These sheets and boats remained perfectly clean for many weeks, as long as the metallic surface of the copper was exposed; but lately, since it has become coated with carbonate of lime and magnesia, weeds have adhered to these coatings, and insects collected on them; but on the sheets of copper, defended by quantities of cast iron and zinc, bearing a proportion below $\frac{1}{150}$, the electrical power of the copper being

ess negative, more neutralised, and nearly in equilibrio with that of the menstruum, no such effect of deposition of alkaline matter or adherence of weeds has taken place, and the surface, though it has undergone a slight degree of solution, has remained perfectly clean: a circumstance of great importance, as it points out the limits of protection; and makes the application of a very small quantity of the oxidable metal more advantageous in fact than that of a larger one.

"The wear of cast iron is not so rapid; but that a mass of two or three inches in thickness will last for some years. At least the consumption in experiments which have been going on for nearly four months does not indicate a higher ratio. This must, however, depend on the relation of its mass to that of the copper, and upon other circumstances not yet ascertained (such as temperature, the relative saltness of the sea, and perhaps the rapidity of the motion of the ship); circumstances in relation to which I am about to make decisive experiments.

"Many singular facts have occurred in the course of these researches. I shall mention some of them, that I have confirmed by repeated experiments, and which have connections with general science.

"Weak solutions of salt act strongly upon copper; strong ones, as brine, do not affect it; and the reason seems to be, that they contain little or no atmospheric air, the oxygene of which seems necessary to give the electro-positive principle of change to menstrua of this class.

"I had anticipated the result of this experiment, and upon the same principle of some others.

"Alkaline solutions, for instance, impede or prevent the action of sea water on copper; having in themselves the positive electrical energy, which renders the copper negative. Lime water even, in this way, renders null the power of action of copper on sea water.

"The tendency of electrical and chemical action being always to produce an equilibrium in the electrical powers, the agency of all combinations formed of metals and fluids is to occasion decompositions, in such an order that alkaline, metallic, and inflammable matters are determined to the negative part of the combination, and chlorine, iodine, oxygene, and acid matters to the positive part. I have shown in the Bakerian lecture for 1806, that this holds good in the Voltaic battery. The same law applies to these feebler combinations. If copper in contact with cast iron be placed in a vessel half full of sea water, and having its surface par-

tially above that of the water; it will become coated with carbonate of lime, carbonate of magnesia, and carbonate of soda; and the carbonate of soda will gradually accumulate till the whole surface in the air is covered with its crystals:— and if the iron is in one vessel, and the copper forming an arc with it in another; and a third vessel of sea water in electrical connection by asbestos or cotton is intermediate, the water in this intermediate vessel continually becomes less saline; and undoubtedly, by a continuance of the process, might be rendered fresh."

Further Researches on the Preservation of Metals by Electro-chemical Means. By Sir HUMPHRY DAVY, Bart.

THE preservation of the copper sheeting of ships from corrosion, by electro-chemical means, having been satisfactorily established by Sir Humphry Davy, he subsequently directed his attention to the important circumstance, how far the cleanness of the bottom of the vessel, or its freedom from the adhesion of weeds, or animals of the polypus and other kinds, would be influenced by this preservation. He says, "As long as the whole surface of the copper changes or corrodes, no such adhesions can occur; but when this green rust has partially formed, the copper below is protected by it, and there is an unequal action produced, the electrical effect of the oxide, submuriate, and carbonate of copper formed, being to produce a more rapid corrosion of the parts still exposed to sea water; so that the sheets are often found perforated with holes in one part, after being used five or six years, and comparatively sound in other parts.

"There is nothing in the poisonous nature of the metal which prevents these adhesions. It is the solution by which they are prevented — the wear of surface. Weeds and shell-fish readily adhere to the poisonous salts of lead which form upon the lead protecting the fore-part of the keel; and to the copper, in any chemical combination in which it is insoluble.

"In general, in ships in the navy, the first effect of the adhesion of weeds is perceived upon the heads of the mixed metal nails, which consist of copper alloyed by a small quantity of tin. The oxides of tin and copper which form upon the head of the nail and in the space round it, defend the metal from the action of sea water; and being negative with respect to it, a stronger corroding effect is produced in its immediate vicinity, so that the copper is often worn into deep and irregular cavities in these parts.

"When copper is unequally worn, likewise in harbours or seas, where the water is loaded with mud or mechanical deposits, this mud or these deposits rest, in the rough parts or depressions in the copper, and in the parts where the different sheets join, and afford a soil or bed in which sea weeds can fix their roots, and to which zoophytes and shell-fish can adhere.

"As far as my experiments have gone, small quantities of other metals, such as iron, tin, zinc, or arsenic, in alloy in copper, have appeared to promote the formation of an insoluble compound on the surface; and, consequently, there is much reason to believe must be favourable to the adhesion of weeds and insects.

"The very first experiment that I made on harbour-boats at Portsmouth proved that a single mass of iron protected fully and entirely many sheets of copper, whether in waves, tides, or currents, so as to make them negatively electrical, and in such a degree as to occasion the deposition of earthy matter upon them; but observations on the effects of the single contact of iron upon a number of sheets of copper, where the junctions and nails were covered with rust, and that had been in a ship for some years, showed that the action was weakened in the case of imperfect connections by distance, and that the sheets near the protector were more defended than those remote from it. Upon this idea I proposed, that when ships, of which the copper sheathing was old and worn, were to be protected, a greater proportion of iron should be used, and that if possible it should be more distributed. The first experiment of this kind was tried on the Sammarang, of 28 guns, in March, 1824, and which had been coppered three years before in India. Cast iron, equal in surface to about $\frac{1}{80}$th of that of the copper, was applied in four masses, two near the stern, two on the bows. She made a voyage to Nova Scotia, and returned in January, 1825. A false and entirely unfounded statement respecting this vessel was published in most of the newspapers, that the bottom was covered with weeds and barnacles. I was present at Portsmouth soon after she was brought into dock: there was not the smallest weed or shell-fish upon the whole of the bottom from a few feet round the stern protectors to the lead on her bow. Round the stern protectors there was a slight adhesion of rust of iron, and upon this there were some zoophytes of the capillary kind, of an inch and a half or two inches in length, and a number of minute barnacles, both Lepas anatifera and Balanus tintinnabulum. For a considerable

space round the protectors, both on the stern and bow, the copper was bright; but the colour became green towards the central parts of the ship; yet even here the rust or verdigrease was a light powder, and only small in quantity, and did not adhere, or come off in scales, and there had been evidently little copper lost in the voyage. That the protectors had not been the cause of the trifling and perfectly insignificant adhesions by any electrical effect, or by occasioning any deposition of earthy matter upon the copper, was evident from this — that the lead on the bow, the part of the ship most exposed to the friction of the water, contained these adhesions in a much more accumulated state than that in which they existed near the stern; and there were none at all on the clean copper round the protectors in the bow; and the slight coating of oxide of iron seems to have been the cause of their appearance.

"I had seen this ship come into dock in the spring of 1824, before she was protected, covered with thick green carbonate and submuriate of copper, and with a number of long weeds, principally fuci, and a quantity of zoophytes, adhering to different parts of the bottom; so that this first experiment was highly satisfactory, though made under very unfavourable circumstances.

"The only two instances of vessels which have been recently coppered, and which have made voyages furnished with protectors, that I have had an opportunity of examining, are the Elizabeth yacht, belonging to the Earl of Darnley, and the Carnebrea Castle, an Indiaman, belonging to Messrs. Wigram. The yacht was protected by about $\frac{1}{125}$th part of malleable iron, placed in two masses in the stern. She had been occasionally employed in sailing, and had been sometimes in harbour during six months. When I saw her in November, she was perfectly clean, and the copper apparently untouched. Lord Darnley informed me, that there never had been the slightest adhesion of either weed or shell-fish to her copper, but that a few small barnacles had once appeared on the loose oxide of iron in the neighbourhood of the protectors, which, however, were immediately and easily washed off. The Carnebrea Castle, a large vessel, of upwards of 650 tons, was furnished with four protectors, two on the stern, and two on the bow, equal together to about $\frac{1}{101}$ of the surface of the copper. She had been protected more than twelve months, and had made the voyage to Calcutta and back. She came into the river perfectly bright; and when examined in the dry dock, was found entirely free from any adhesion, and

offered a beautiful and almost polished surface; and there seemed to be no greater wear of copper than could be accounted for from mechanical causes.

"At Liverpool, as I am informed, several ships have been protected, and have returned after voyages to the West Indies, and even to the East Indies. The proportion of protecting metal in all of them has been beyond what I have recommended, $\frac{1}{90}$ to $\frac{1}{70}$; yet, two of them have been found perfectly clean, and with the copper untouched, after voyages to Demarara; and another nearly in the same state, after two voyages to the same place. Two others have had their bottoms more or less covered with barnacles; but the preservation of the copper has been in all cases judged complete. The iron has been placed along the keel on both sides; and the barnacles, in cases where they have existed, have been generally upon the flat of the bottom; from which it may be concluded, that they adhered either to the oxide of iron, or the calcareous deposits occasioned by the excess of negative electricity.

"In the navy, the proportion adopted has been only $\frac{1}{150}$ of cast iron, at least for vessels in actual service, and when the object is rather cleanness than the preservation of the copper.

"It is very difficult to point out the circumstances which [illegible] results, such as these mentioned with respect to Liverpool traders, so different under apparently the same circumstances, *i. e.* why ships should exhibit no adhesions or barnacles after two voyages, whilst on another ship, with the same quantity of protection, they should be found after a single voyage. This may probably depend upon one ship having remained at rest in harbour longer than another, or having been becalmed for a short time in shallow seas, where ova of shell-fish, or young shell-fish existed; or upon oxide of iron being formed, and not washed off, in consequence of calm weather, and which consolidating, was not afterwards separated in the voyage. From what I can learn, however, the chance of a certain degree of foulness, in consequence of the application of the full proportion of protecting metal, will not prevent ship owners from employing this proportion, as the saving of copper is a very great object; and as long as the copper is sound, no danger is to be apprehended from worms.

"The copper used for sheathing should be the purest that can be obtained; and in being applied to the ship, its surface should be preserved as smooth and equable as possible: and the nails used for fastening should likewise be of pure copper;

and a little difference in their thickness and shape will easily compensate for their want of hardness.

"In vessels employed for steam navigation, the protecting metal can scarcely be in excess, as the rapid motion of these ships prevents the chance of any adhesions; and the wear of the copper, by proper protection, is diminished more than two thirds."

On the magnetising Power of the more refrangible Solar Rays. By Mrs. M. Somerville.

"In the year 1813, Professor Morichini of Rome discovered that steel, exposed to the violet rays of the solar spectrum, becomes magnetic. His experiments were repeated by Professor Configliachi at Pavia, and also by Mons. Berard, at Montpellier, without success. I am not aware of any one having attempted them in this country, perhaps from the belief that experiments which had sometimes failed in Italy were not likely to succeed in our more northern climate. The unusual clearness of the weather last summer, however, induced me to try what could be accomplished in this country. Accordingly, in the month of July, an equiangular prism of flint glass, the three sides of which were each 1.4 by 1.1 inches, was fixed in a slit made to receive it in a window-shutter: by this prism a coloured spectrum was thrown on an opposite panel, at the distance of about five feet. I used for the subject of experiment a very slender sewing needle an inch long, having previously ascertained that it was quite free from magnetism, by repeated exposure of both ends of it to the north and south pole of a very sensible magnetic needle, when it was found equally to attract either pole in every instance. The magnetic needle employed as a test in this experiment is made of a sewing needle magnetised, and run through a small piece of cork, into which a conical cap of glass is inserted; the whole traverses on the point of a needle fixed perpendicularly in a stand.

"I had no information at this time of the manner in which Professor Morichini had conducted his experiments; but it occurred to me that it was not likely that if the whole of the needle were equally exposed to the violet rays, the same influence should, at the same time, produce a south pole at one end of it, and a north pole at the other. I therefore covered half of the needle with paper, and fixed it to the panel with wax, between ten and eleven in the morning, in such a position that the uncovered part of it should be exposed

to the violet rays. The needle was placed in a vertical plane, nearly perpendicular to the magnetic meridian, and inclined to the horizon. As I had not a heliostat, it was necessary to move the needle in a direction parallel to itself, to keep the exposed portion of it constantly in the violet ray.

"The sun was bright at the time, and in less than two hours I had the gratification to find that the end of the needle which had been exposed to the violet rays attracted the south pole of the magnetic needle, and repelled the north pole. It had been previously ascertained that there was no iron near to disturb the results. The experiment was also repeated on the same day, under precisely similar circumstances, with the view of detecting any source of error that might have escaped observation in a first attempt; but the result was the same as in the first.

"The season was so favourable that it afforded me daily opportunity of repeating the experiments, varying the size of the needles, always taking especial care to ascertain that they were free from magnetism. The needles were placed in various directions in the plane of the magnetic meridian, sometimes in the angle of the dip, sometimes perpendicular to the magnetic meridian, and also at various angles with regard to it. In some cases the heads of the needles were exposed, in place of the points, to the violet rays. Perhaps it might have been expected that the influence would have been greater in those instances in which the needles were placed in the plane of the magnetic meridian, and at the angle of the dip; and, consequently, polarity might have been expected to take place in a shorter time under these circumstances; yet in fact there seemed to be no difference; most of the needles became magnetic, some in longer, others in shorter periods, varying from about half an hour to four hours, but depending on circumstances which I have not yet been able to detect, further than that a number of results induced me to believe, that the experiments were more successful from 10 to 12, or one o'clock, than later in the day. The portion of the needle exposed was almost always a north pole, whether it pointed upwards or downwards. In a few instances in which the contrary occurred, it may possibly have arisen from some previous disposition in the needle to magnetism, too slight to be observed.

"The distance of the needle from the prism was frequently varied by fixing the needle to the wooden pole of a fire-screen, but without material variation in the effect. I found it unnecessary to darken the room; it was sufficient to place the

prism, so as to throw the spectrum on any place out of the sun's rays.

"My next object was to endeavour to ascertain whether any other of the more refrangible rays had the same property as the violet. A set of needles carefully examined as before were therefore subjected to the different rays of the solar spectrum; the needles exposed to blue and green rays, sometimes acquired the magnetic property, though less frequently, and requiring longer exposure than when the violet rays were used; but the magnetism seemed to be equally strong in these as in the examples of the violet rays. The part exposed became a north pole. The indigo rays succeeded almost as well as the violet."

Mrs. Somerville then tried the experiment with pieces of watch-spring; supposing that from their blue colour they might be more susceptible of the magnetic influence; and it was the case, though, she thinks, their greater extent of surface, or their softness, may have contributed to this susceptibility.

"I was desirous of ascertaining whether dark-blue glass suffered the chemical rays to pass, and thereby occasion these changes in the steel, therefore I employed a liquid holding muriate of silver in suspension, as a test, in the following manner: a piece of writing paper dipped in the liquid was cut into two equal parts, of which one was placed under the blue glass, and the other under a white glass, as nearly at the same time as possible; but the one did not become black sooner than the other; nor on comparing them could any difference be perceived in intensity of colour, both having been equally exposed to the chemical rays. The experiment was repeated with the same result.

"On the 26th of August, the thermometer at noon being 66°, two neutral pieces of clock-spring were exposed to the sun, one under a thicker piece of the same blue glass, as in the former experiment, and the other under green glass; both acquired polarity.

"To learn if heat had any share in producing magnetism in this case, I exposed three pieces of the same steel to a bright sunshine, on the 1st of September, the thermometer at noon being at 70°: one half of each was covered with paper, but the other half had neither glass nor ribbon over it; and although the heat was greater than on the preceding day, no magnetism was produced.

"On the 2d of September, thermometer at noon 68°, a piece of neutral white steel acquired polarity from exposure

to the sun, enveloped in green ribbon, one half being covered with paper as before.

"On the 3d of September, thermometer at noon 68°, two pieces of neutral spring became magnetic, one exposed in a violet-coloured ribbon, and the other in blue glass, while a similar piece of spring was in no way affected by exposure to white light: the half of each was covered with paper."

On the nervous Circle which connects the voluntary Muscles with the Brain. By CHARLES BELL, *Esq.*

THE object of this paper is the developement of the facts which confirm the opinion that Mr. Bell had previously advanced; — that the nerves of sensation and motion are wholly distinct from each other; — and to demonstrate, that when nerves of different functions take their origin apart and run a different course, two nerves must unite in the muscles, in order to perfect the relation between the brain and these muscles. He has shown, in respect to the nerves of the face, that, by dividing one nerve, sensation was destroyed, whilst motion remained; and by dividing the other, motion was prevented, whilst sensibility remained entire. He says, —

"For a time I believed that the fifth nerve, which is the sensitive nerve of the head and face, did not terminate in the substance of the muscles, but only passed through them to the skin; and I was the more inclined to this belief on observing that the muscular parts when exposed in surgical operations did not possess that exquisite sensibility which the profusion of the sensitive nerves would imply, or which the skin really possesses.

"Still dissection did not authorise this conclusion. I traced the sensitive nerves into the substance of the muscles: I found that the fifth pair was distributed more profusely to the muscles than to the skin; and that estimating all the nerves given to the muscles, the greater proportion belonged to the fifth or sensitive nerve, and the smaller proportion to the seventh or motor nerve. On referring to the best authorities as Meckel, and my excellent preceptor Monro, the extremities of the fifth were described by them as going into th muscles, so that of this fact there cannot be a doubt.

"Having in a former paper demonstrated that the por dura of the seventh nerve was the motor of the face, and tl it ran distinct from the sensitive nerve, the fifth, and observ that they joined at their extremities, or plunged together i the muscles, I was nevertheless unwilling to draw a conclu

from a single instance; and therefore cast about for other examples of the distribution of the muscular nerves. It was easy to find motor nerves in combination with sensitive nerves, for all the spinal nerves are thus composed; but we wanted a muscular nerve clear in its course, to see what alliance it would form in its ultimate distribution in the muscle. I found in the lower maxillary nerve the example I required.

"The fifth pair, from which this lower maxillary nerve comes, as I have elsewhere explained, is a compound nerve; that is to say, it is composed of a nerve of sensation, and a nerve of motion. It arises in two roots, one of these is the muscular nerve, the other the sensible nerve: on this last division the Gasserian ganglion is formed. But we can trace the motor nerve clear of the ganglion and onward in its course to the muscles of the jaws, and so it enters the temporal masseter pterygoid and buccinator muscles.

"If all that is necessary to the action of a muscle be a nerve to excite to contraction, these branches should have been unaccompanied; but on the contrary, I found that before these motor nerves entered the several muscles, they were joined by branches of the nerves which came through the Gasserian ganglion, and which were sensitive nerves.

"I found the same result on tracing motor nerves into the orbit, and that the sensitive division of the fifth pair of nerves was transmitted to the muscles of the eye, although these muscles were supplied by the third, fourth, and sixth nerves.

"A circumstance observed on minute dissection remained unexplained, — when motor nerves are proceeding to several muscles they form a plexus; that is, an interlacement and exchange of fibres takes place.

"The muscles have no connection with each other, they are combined by the nerves; but these nerves, instead of passing betwixt the muscles, interchange their fibres before their distribution to them, and by this means combine the muscles into classes. The question, therefore, may thus be stated: why are nerves, whose office it is to convey sensation, profusely given to muscles in addition to those motor nerves which are given to excite their motions? and why do both classes of muscular nerves form plexus?

"To solve this question, we must determine whether muscles have any other purpose to serve than merely to contract under the impulse of the motor nerves. For if they have a reflective influence, and if their condition is to be felt or perceived, it will presently appear that the motor nerves are not suitable internuncii betwixt them and the sensorium.

"I shall first enquire, if it be necessary to the governance of the muscular frame that there be a consciousness of the state or degree of action of the muscles? That we have a sense of the condition of the muscles appears from this; that we feel the effects of over-exertion and weariness, and are excruciated by spasms, and feel the irksomeness of continued position. We possess a power of weighing in the hand: — what is this but estimating the muscular force? We are sensible of the most minute changes of muscular exertion, by which we know the position of the body and limbs, when there is no other means of knowledge open to us. If a rope-dancer measures his steps by the eye, yet on the other hand a blind man can balance his body. In standing, walking, and running, every effort of the voluntary power, which gives motion to the body, is directed by a sense of the condition of the muscles, and without this sense we could not regulate their actions.

"If it were necessary to enlarge on this subject, it would be easy to prove that the muscular exertions of the hand, the eye, the ear, and the tongue, are felt and estimated when we have perception through these organs of sense; and that without a sense of the actions of the muscular frame, a very principal inlet to knowledge would be cut off.

"If it be granted, that there must be a sense of the condition of the muscle, we have next to show that a motor nerve is not a conductor towards the brain, and that it cannot perform the office of a sensitive nerve.

"Without attempting to determine the cause, whether depending on the structure of the nervous cord, or the nature, or the source of the fluid contained, a pure or simple nerve has the influence propagated along it in one direction only, and not backwards and forwards; it has no reflected operation or power retrograde; it does not both act from and to the sensorium.

"Indeed reason without experience would lead us to conclude, that whatever may be the state, or the nature of the activity of a motor nerve during exertion, it supposes an energy proceeding *from* the brain *towards* the muscles, and precludes the activity of the same nerve in the opposite direction at the same moment. It does not seem possible, therefore, that a motor nerve can be the means of communicating the condition of the muscles to the brain.

"Expose the two nerves of a muscle; irritate one of them, and the muscle will act; irritate the other, and the muscle remains at rest. Cut across the nerve which had the power of exciting the muscle, and stimulate the one which is undi-

vided — the animal will give indication of pain; but although the nerve be injured so as to cause universal agitation, the muscle with which it is directly connected does not move. Both nerves being cut across, we shall still find that by exciting one nerve the muscle is made to act, even days after the nerve has been divided; but the other nerve has no influence at all.

"Anatomy forbids us to hope that the experiment will be as decisive when we apply the irritants to the extremities of the divided nerves which are connected with the brain; for all the muscular nerves receive more or less minute filaments of sensitive nerves, and these we can trace into them by the knife, and, consequently, they will indicate a certain degree of sensibility when hurt. To expose these nerves near their origins, and before any filament of a sensitive nerve mingles with them, requires the operator to cut deep, to break up the bones, and to divide the blood-vessels. All such experiments are much better omitted; they never can lead to satisfactory conclusions.

"Now it appears the muscle has a nerve in addition to the motor nerve, which being necessary to its perfect function equally deserves the name of muscular. This nerve, however, has no direct power over the muscle, but circuitously through the brain, and by exciting sensation it may become a cause of action.

"Between the brain and the muscles there is a circle of nerves: one nerve conveys the influence from the brain to the muscle, another gives the sense of the condition of the muscle to the brain. If the circle be broken by the division of the motor nerve, motion ceases; if it be broken by the division of the other nerve, there is no longer a sense of the condition of the muscle, and therefore no regulation of its activity.

"We have noticed, that there is a plexus formed both on the nerves which convey the will to the muscles, and on the nerves which give the sense of the condition of the muscles. The reason of this I apprehend to be that the nerves must correspond with the muscles, and, consequently, with one another. If the motor nerve has to arrange the action of several muscles so as to produce a variety of motions, the combinations must be formed by the interchange of filaments, among the nerves before they enter the muscles, as there is no connection between the muscles themselves. As the various combinations of the muscles have a relation with the motor nerves, the same relations must be established by those nerves which convey the impression of their combinations,

and a similar plexus or interchange of filaments therefore characterises both.

"We have seen that the returning muscular nerves are associated with the nerves of sensibility to the skin, but they are probably very distinct in their endowments, since there is a great difference between conveying the sense of external impressions and that of muscular action.

"In surgical operations the fact is forced upon our attention, that the pain of cutting the skin is exquisite, compared with that of the muscles; but we must remember that pain is a modification of the endowment of a nerve, serving as a guard to the surface, and to the deeper parts consequently. This is further exemplified in the sensibility of the skin to heat; whilst, on the contrary, a muscle touched with a hot or cold sponge, during an operation, gives no token of the change of temperature but by the degree of pain.

"Many of the nerves which perform the most delicate operations in the economy are not more sensible to pain than the common texture of the frame. The lower degree of sensibility to pain possessed by the muscles, and their insensibility to heat, is no argument against their having nerves which are alive to the most minute changes of action in their fibres."

On the Phenomena of Volcanoes. By Sir Humphry Davy, *Bart. F.R.S.*

When in the years 1807 and 1808 I discovered that the alkalies and the earths were composed of inflammable matter united to oxygen, a number of enquiries suggested themselves with respect to various parts of chemical science, some of which were capable of being immediately assisted by experiment, and others required for their solution a long series of observations, and circumstances obtained only with difficulty. Of the last kind were the inferences concerning the geological appearances connected with these discoveries.

The metals of the alkalies, and those of such of the earths as I had decomposed, were found to be highly combustible, and altered by air and water, even at the usual temperatures of the atmosphere; it was not possible, consequently, that they should be found at the surface of the globe, but probable that they might exist in the interior; and allowing this hypothesis, it became easy to account for volcanic fires, by exposure of the metals of earths and alkalies to air and water; and to explain, not only the formation of lavas, but likewise that of basalts, and many other crystalline rocks, from the

slow cooling of the products of combustion or oxidation of the newly-discovered substances.

I developed this opinion in a paper on the decomposition of the earths, published in 1808; and since 1812 I have endeavoured to gain evidence respecting it, by examining volcanic phenomena of ancient and recent occurrence in various parts of Europe.

In this communication I shall have the honour of laying before the Royal Society some results of my enquiries. If they do not solve the problem respecting the cause of volcanic fires, they will, I trust, be found to offer some elucidations of the subject, and may serve as the foundation of future labours.

The active volcano on which I have made my observations is Vesuvius; and there probably does not exist another so admirably fitted for the purpose: its vicinity to a great city; the facility with which it may be ascended in every season of the year; and the nature of its activity, — all offer peculiar advantages to the philosophic enquirer.

I had made several observations on Vesuvius in the springs of 1814 and 1815, which I shall refer to on a future occasion in these pages; but it was in December, 1819, and January and February, 1820, that the volcano offered the most favourable opportunity for investigation. On my arrival at Naples, Dec. 4., I found that there had been a small eruption a few days before, and that a stream of lava was flowing with considerable activity, from an aperture in the mountain a little below the crater. On the 5th I ascended the mountain, and examined the crater and the stream of lava. The crater emitted so large a quantity of smoke, with muriatic and sulphurous acid fumes, that it was impossible to approach it, except in the direction of the wind; and it threw up, every two or three minutes, showers of red-hot stones. The lava was flowing from an aperture about 100 yards below it, being apparently forced out by elastic fluids, with a noise like that made by the steam disengaged from a pressure engine: it rose, perfectly fluid, forming a stream of from five to six feet in diameter, and immediately fell, as a cataract, into a chasm about 40 feet below, where it was lost under a kind of bridge formed of cooled lava; but it re-appeared 60 or 70 yards further down. Where it issued from the mountain, it was nearly white-hot, and exhibited an appearance similar to that which is shown when a pole of wood is introduced into the melted copper of a foundery, its surface appearing in violent agitation, large bubbles rising, which in bursting produced a white smoke; but the lava became of a red colour, though

still visible in the sunshine, where it issued from under the bridge. The force with which it flowed was so great, that the strength of the guide, a very stout young man, was insufficient to keep a long iron rod in the current. The whole of its course, with two or three interruptions, where it flowed under a cooled surface, was nearly three quarters of a mile, and it threw off clouds of a white smoke. It smoked less as it cooled and became pasty; but even where it terminated in moving masses of scoria, smoke was still visible, which became more distinct whenever the scoria was moved, or the red-hot lava in the interior exposed.

Having ascertained that it was possible to approach within four or five feet of the lava, and to examine the vapour immediately close to the aperture, I returned the next day, having provided the means of making a number of experiments on the nature of the lava, and of the elastic fluids with which it was accompanied. I found the aperture nearly in the same state as the day before, but the lava spread over a larger surface, forming an eddy in the hollow of the rock, over which it fell, from which it could be raised in an iron ladle more easily than from the current, and where there was much more facility of placing and withdrawing substances intended to be exposed to its agency.

One of the most important points to be ascertained was, whether any combustion was going on at the moment the lava issued from the mountain. There was certainly no appearance of more vivid ignition when it was exposed to air, nor did it glow with more intensity when it was raised into the air by an iron ladle. I put the circumstance, however, beyond the possibility of doubt: I threw some of the fused lava into a glass bottle furnished with a ground stopper, containing siliceous sand in the bottom: I closed it at the moment, and examined the air on my return. A measure of it mixed with a measure of nitrous gas gave exactly the same degree of diminution as a measure of common air, which had been collected in another bottle on the mountain.

I threw upon the surface of the lava nitre, both in mass and in powder. After this salt had fused, there was a little increase of vividness in the ignition of the lava, but much too slight to be referred to pure combustible matter in any quantity; and on making the experiment on a portion of lava taken up in the ladle, it appeared that the disengagement of heat was partly owing to the peroxidation of the protoxide of iron, and to the combination of the alkali of the nitre with the earthy basis of the lava; for where the nitre had melted,

the colour had changed from olive to brown. This conclusion was still farther proved by the circumstance, that chlorate of potash thrown upon the lava did not increase its degree of ignition so much as nitre. When a stick of wood was introduced into a portion of the lava, so as to leave a little carbonaceous matter on its surface, nitre or chlorate of potassa then thrown upon it caused it to glow with great brilliancy. Some fused lava was thrown into water, and a glass bottle filled with water held over it to collect the gas disengaged: it was in very minute quantity only; and when analysed on my return, proved to be common air, a little less pure than that disengaged from the water by boiling. A wire of copper of $\frac{1}{20}$th of an inch in diameter, and a wire of silver of $\frac{1}{30}$th, introduced into the lava near its source, were instantly fused: an iron rod of one fifth of an inch, with a piece of iron wire of about $\frac{1}{30}$th, were kept for five minutes in the eddy in the stream of lava: they were not fused; they did not produce any smell of sulphuretted hydrogen when acted on by muriatic acid. A tin-plate funnel, filled with cold water, was held in the fumes disengaged with so much violence from the aperture through which the lava issued: fluid was immediately condensed upon it, which was of an acid and subastringent taste. It did not precipitate muriate of baryta. but copiously precipitated nitrate of silver, and rendered the triple prussiate of potassa of a bright blue. When the same funnel was held in the white fumes above the lava, where it entered the bridge, no fluid was precipitated upon it, but it became coated with a white powder, which had the taste and chemical qualities of common salt, and proved to be this substance absolutely pure. A bottle of water holding about three fourths of a pint, with a long narrow neck, was emptied immediately in the aperture from which the vapours pressing out the lava issued, and the neck was immediately closed. This air, examined on my return, was found to give no absorption with solution of potassa; so that it contained no notable proportion of carbonic acid, and it consisted of nine parts of oxygen, and 91 of azote. There was not the least smell of sulphurous acid in the vapour from the aperture, nor were the fumes of muriatic acid so strong as to be unpleasant; but during the last quarter of an hour that I was engaged in these experiments, the wind changed, and blew the smoke from the crater upon the spot where I was standing: the sulphurous acid gas in the fumes was highly irritating to the organs of respiration, and I suffered so much from the exposure to them, that I was obliged to descend; and the

effect was not transient, for a violent catarrhal affection ensued, which prevented me for a month from again ascending the mountain.

On the 6th of January, I made another visit to Vesuvius. I found the appearance of the lava considerably changed: the bocca from which it issued on the 5th of December was closed, and the current now flowed quietly and without noise, from a chasm in the cooled lava, about 800 feet lower down. The heat was evidently less intense. I repeated my experiments with nitre with the same results, and exposed pure silver and platinum to the fused lava: they were not at all changed in colour. I collected the sublimations from various parts of the cooled lava above. The rocks near the ancient bocca were entirely covered with white, yellow, and reddish saline substances. I found one specimen of large saline crystals in a cavity, which had a slight tint of purple: this examined, proved to be common salt, with a minute portion of muriate of cobalt. The other sublimations consisted of common salt in great excess, much chloride of iron, some sulphate of soda; and by the test of muriate of platinum there appeared to exist in them a small quantity of sulphate or muriate of potassa; and a solution of ammonia detected the presence of a minute quantity of the oxide of copper.

During the months of January and February, I made several visits to the top of Vesuvius: I shall not particularise them all; but shall mention only such as afforded me some new observations. On the 26th of January, the lava was seen nearly white-hot, through a chasm near the place where it flowed from the mountain. I threw nitre upon it in large quantities through this chasm, in the presence of His Royal Highness the Prince of Denmark, whom I had the honour of accompanying in this excursion to the mountain, and my friend the Cavaliere Monticelli: there was no more increase of ignition than when the experiment was made on lava exposed to the free air. The appearance of the sublimations was now considerably changed: those near the aperture were coloured green and blue by salts of copper; but there was still a great quantity of muriate of iron. I have mentioned that on the 5th, the sublimate of the lava was pure chloride of sodium: in the sublimate of January 6th, there were both sulphate of soda and indications of sulphate of potassa. In the sublimates that I collected on the 26th, the sulphate of soda was in much larger quantities, and there was much more of a salt of potassa. From the 5th of December to the 20th of February, the lava flowed in larger or smaller quan-

tities, so that at night a stream of ignited matter was always visible, more or less interrupted by cooled lava. It changed its direction according to the obstacles it met with; and never, according to appearances, extended so much as a mile from its source. During the whole of this time, the craters, of which there were two, were in activity. The large crater threw up showers of ignited ashes and stones to a height apparently of from 200 to 500 feet; and from a smaller crater, to the right of the large one on the side of Naples, steam arose with great violence. Whenever the crater could be approached, it was found incrusted with saline incrustations; and the walk to the edge of the small crater, on the 6th of January, was through a mass of loose saline matter, principally common salt, coloured by muriate of iron, in which the foot sunk to some depth. It was easy, even at a great distance, to distinguish between the steam disengaged by one of the craters and the earthy matter thrown up by the other. The steam appeared white in the day, and formed perfectly white clouds, which reflected the morning and evening light of the purest tints of red and orange. The earthy matter always appeared as a black smoke, forming black clouds; and in the night it was highly luminous at the moment of the explosion.

On the 20th of February, the small crater, which had been disengaging steam and elastic matter, began to throw out showers of stones; and both craters, from the 20th to the 23d, were more than usually active. On the night of the 23d, at half past 11 o'clock, being in my bed-room at Chiatimone, Naples, I heard the windows shake; and going to the window, I saw ascending from Vesuvius a column of ignited matter, to a height at least equal to that of the mountain from its base; and the whole horizon was illuminated, notwithstanding the brightness of the moon, with direct volcanic light, and that reflected from the clouds above the column of ignited matter. Several eruptions of the same kind, but upon a smaller scale, followed at intervals of a minute and a half or two minutes; but there were no more symptoms of earthquake, nor did I hear any noise. On observing the lava, it appeared at its origin much broader and more vivid; and it was evident that a fresh stream had broken out to the right of the former one. On the morning of the 24th, I visited the mountain: it was not possible to ascend to the top, which was covered with clouds, nor to examine the orifice from which the lava issued. The stream of lava near the place where it terminated was from 50 to 100 feet broad. It had precisely

the same appearances as the lava which had been so long running. I collected the saline matter condensed upon some of the masses of scoria which were carried along by the current, and deposited on the edge of the stream; they proved to be the same in the nature of their constituent parts as those of the lava of the 26th of January, but with a larger proportion of sulphate of soda, and a smaller proportion of muriate of iron; and I have no doubt that the dense white smoke, which was emitted in immense columns by the lava during the whole of its course, was produced by the same substances.

I shall now mention the state of the volcano at some other periods.

When I was at Naples in May, 1814, the crater had the appearance of an immense funnel, closed at the bottom, with many small apertures emitting steam; and on the side towards Torre del Greco there was a large aperture, from which flame issued to a height of at least 60 yards, producing a most violent hissing noise. This phenomenon was constant during the three weeks I remained at Naples. It was impossible to approach sufficiently near the flame to ascertain the results of the combustion; but a considerable quantity of steam ascended from it. When the wind blew the vapours upon us, there was a distinct smell both of sulphurous and muriatic acids. There was no indication of carbonaceous matter from the colour of the smoke; nor was any deposited upon the yellow and white saline matter which surrounded the crater, and which I found to be principally sulphate and muriate of soda, and muriate of iron: in some specimens there was a considerable quantity of muriate of ammonia.

In March, 1815, the appearances presented by the crater were entirely different. There was no aperture in the crater: it was often quiet for minutes together, and then burst out into explosions with considerable violence, sending [illegible] a and ignited stones and ashes to a considerable height, many hundred feet, in the air.

These eruptions were preceded by subterraneous thunder, which appeared to come from a great distance, and which sometimes lasted for a minute. During the four times that I was upon the crater in the month of March, I had at last learnt to estimate the violence of the eruption from the nature of the sound; loud and long continued subterraneous thunder indicated a considerable explosion. Before the eruption, the crater appeared perfectly tranquil; and the bottom, apparently without an aperture, was covered with

propelled by steam; which must possess, under the circumstances, at least the same facility of oxidating them as air. Assuming the hypothesis of the existence of such alloys of the metals of the earths as may burn into lava in the interior, the whole phenomena may be easily explained from the action of the water of the sea and air on those metals; nor is there any fact, or any of the circumstances which I have mentioned in the preceding part of this paper, which cannot be easily explained according to that hypothesis. For almost all the volcanoes in the old world of considerable magnitude are near, or at no considerable distance from the sea: and if it be assumed that the first eruptions are produced by the action of sea water upon the metals of the earths, and that considerable cavities are left by the oxidated metals thrown out as lava, the results of their action are such as might be anticipated; for, after the first eruptions, the oxidations which produce the subsequent ones may take place in the caverns below the surface; and when the sea is distant, as in the volcanoes of South America, they may be supplied with water from great subterranean lakes; as Humboldt states that some of them throw up quantities of fish.

On the hypothesis of a chemical cause for volcanic fires, and reasoning from known facts, there appears to me no other adequate source than the oxidation of the metals which form the basis of the earths and alkalies; but it must not be denied, that considerations derived from thermometrical experiments on the temperature of mines, and of sources of hot water, render it probable that the interior of the globe possesses a very high temperature; and the hypothesis of the nucleus of the globe being composed of fluid matter offers a still more simple solution of the phenomena of volcanic fires than that which has been just developed.

THE END.